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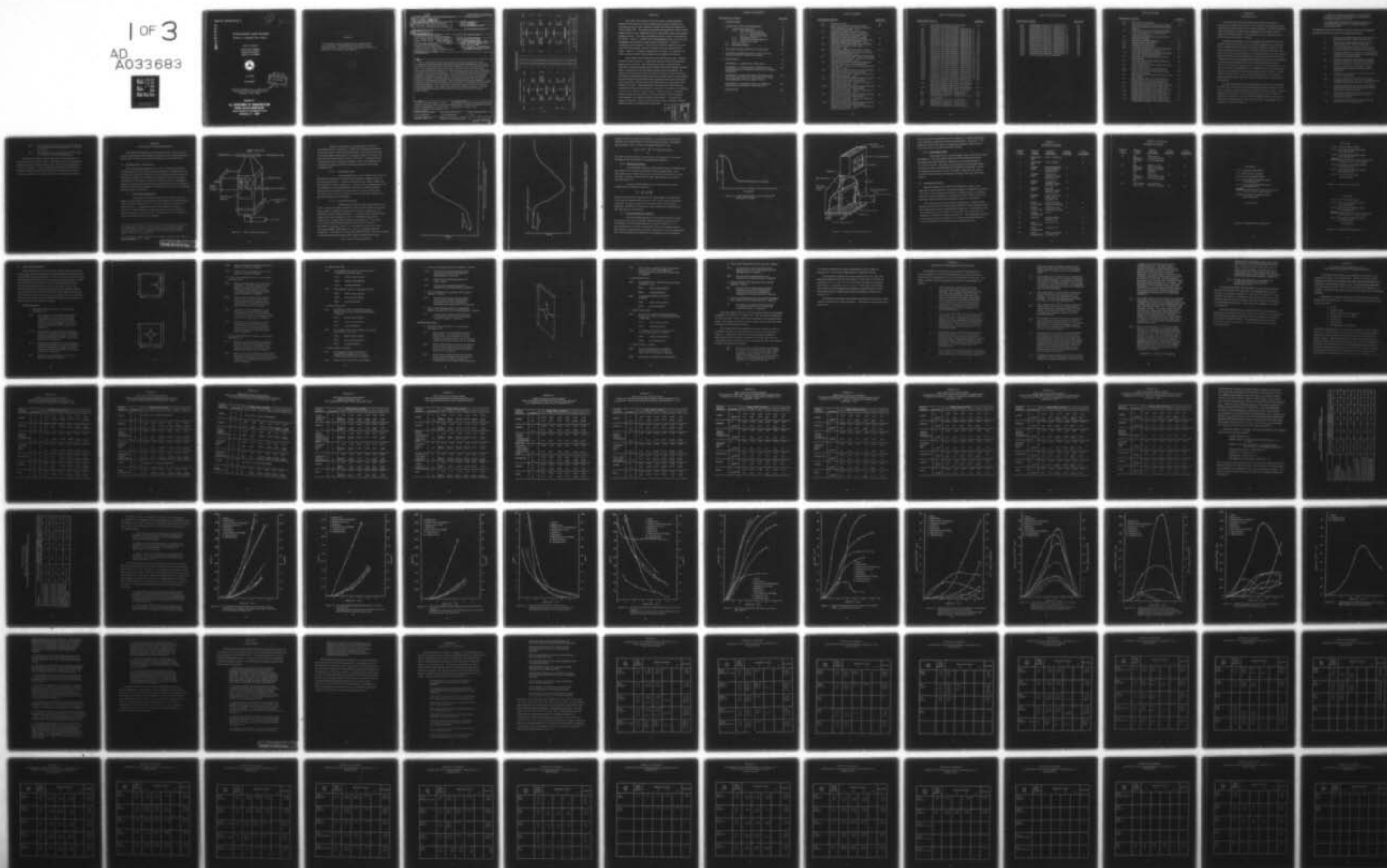

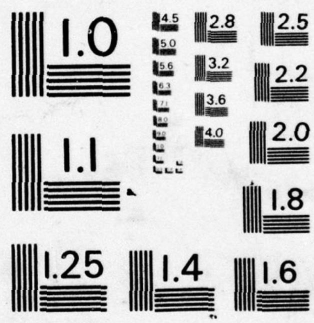

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Report No. FAA-RD-76-120, II

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DAYTON AIRCRAFT CABIN FIRE MODEL

Volume II - Laboratory Test Program

Jerry B. Reeves
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Dayton, Ohio 45469

June 1976

Final Report

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
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16. Abstract

A basic mathematical model and computer simulation program have been developed to assess the smoke and toxic gas emissions resulting from the burning of cabin interior materials of a wide-body transport aircraft in a full-scale cabin fire. The simulation is based on laboratory test data on the cabin materials. This report presents the results of a laboratory test program which was conducted in support of the model development. Various flammability and combustion toxicity properties were measured for several wide-body cabin materials by The Boeing Commercial Airplane Company under a subcontract to the University of Dayton Research Institute. The measurements were made using the OSU Combustion Analyzer, the NBS Smoke Chamber, and the Boeing Burn-Through Apparatus. This report describes the test procedures, the test results, the analysis of the test data, and the development of a set of material properties input data for the cabin fire simulation program. This report consists of three volumes; Volume I is entitled "Basic Mathematical Model" and Volume III is entitled "Computer Program User's Guide".

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aircraft cabin fire safety, aircraft interior materials, smoke & toxic gases, material flammability, aircraft cabin fires, laboratory test methods, wide-body aircraft

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METRIC CONVERSION FACTORS

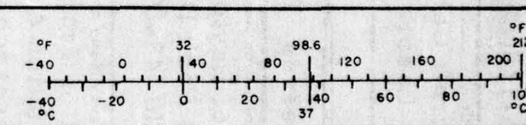
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This report was prepared by the University of Dayton Research Institute for the Federal Aviation Administration Systems Research and Development Service under Contract FA74WA-3532 during the period July 1974 to March 1976. The report describes the development of a basic mathematical model of a fire within the cabin of a wide-body commercial transport category aircraft. The report is divided into three volumes of which this is the second. Volume 1, entitled "Basic Mathematical Model", describes the development and presents example results of the model. Volume 2, "Laboratory Test Program", presents the results of a laboratory test and data collection program conducted in support of the development of the model. Volume 3, "Computer Program User's Guide", is a guide for use of the computer program which implements the mathematical model.

This contract was administered under the direction of Mr. Robert C. McGuire and Mr. Charles C. Troha of the Systems Research and Development Service, ARD 520. The laboratory tests were conducted by the Materials Technology Division of The Boeing Commercial Airplane Company under a subcontract to the University of Dayton Research Institute. Dr. James M. Peterson directed the test effort at Boeing and made significant and valuable contributions to this report for which the author is very grateful. The data analysis was performed by the Applied Systems Analysis Division of the University of Dayton Research Institute under the supervision of Mr. Nicholas A. Engler. Other personnel at the Research Institute who have contributed to the program include Mr. Charles D. MacArthur, Mr. Michael J. Geraci, Mr. Peter M. Kahut, and Mr. James K. Luers. The author wishes to express his gratitude to all those mentioned for their support, encouragement, and valuable technical contributions. The author also wishes to thank Ms. Jacquelin Aldrich and Ms. Peggy Cummings for their patient assistance in preparing the manuscript.

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SECTION 1

INTRODUCTION

This report describes the methods and presents the results of a laboratory test program to measure various material combustion properties representative of wide-body aircraft interior materials. The data collection effort was initiated to facilitate the development of the Dayton Aircraft Cabin Fire (DACFIR) Model. The laboratory tests were conducted by the Boeing Commercial Airplane Company.

During the initial phase of the development of the DACFIR Model, the available laboratory test data on aircraft interior materials was reviewed. It was concluded that the available data did not sufficiently define the combustion properties of materials for the purpose of predicting the materials behavior in a full-scale fire situation. One of the problems with the available data was that flame spread information for materials of interest could only be obtained in the form of a flame spread index which is useful for comparison of one material to another but does not define the actual flame spread rates of the materials in physical units, e.g. ft/sec. A second problem was that the tests were performed at only one applied heat flux level so that the behavior of the material at different heat fluxes was not available. A third problem was that data for some of the time parameters, such as time to ignite at any flux level, associated with the combustion of a material were not available.

In order to obtain data of the type needed for mathematical modeling of cabin fires, the University of Dayton Research Institute (UDRI) entered into a subcontract agreement with the Boeing Commercial Airplane Company. Boeing conducted tests on aircraft interior materials using, among other apparatus, an Ohio State University (OSU) Combustion Analyzer which was well suited to generate much of the data of interest. The purposes of the laboratory test program were to:

1. define the combustion properties of representative wide-body aircraft cabin materials at varying levels of applied radiant heat flux; and

2. provide specific input data so that the performance of the DACFIR model could be evaluated using this representative data.

The laboratory tests were designed to provide values for the following parameters required as input to the mathematical model.

f_h - The horizontal flame spread rate on a vertical or horizontal sample as a function of heat flux.

f_u - The vertically upward flame spread rate on a vertical sample as a function of heat flux.

f_d - The vertically downward flame spread rate on a vertical sample as a function of the heat flux.

t_f - The time required for a material to begin flaming combustion after being exposed to a pilot flame as a function of incident heat flux.

t_{fc} - The time required for the material to become charred ("burned-out" and inert) as a result of flaming combustion as a function of heat flux.

t_p - The time required for the material to begin smoldering when exposed to different levels of heat flux.

t_{pc} - The time for the material to become charred as a result of smoldering.

t_{pe} - The time required for the material to cease emitting smoke and/or toxic gases when smoldering is induced and then the heat flux is removed.

r_h - The heat release rate per unit area for flaming and (if applicable) for smoldering materials as a function of incident heat flux.

r_{sf} - The smoke release rate per unit area for the material in the flaming state as a function of incident heat flux.

r_{ss} - The smoke release rate per unit area for the material in the smoldering state.

$r_f(i)$ - The release rate per unit area of the i^{th} toxic gas for the material in the flaming state as a function of heat flux.

$r_s(i)$ - The release rate per unit area of the i^{th} toxic gas for the material in the smoldering state.

The materials tested in the laboratory and the data generated is discussed in Section 2 of this report. The analysis which was performed on the laboratory test data to provide values for the above parameters is discussed in Section 3. The set of material properties data which were developed as input to test the DACFIR Model is presented in Section 4. Conclusions reached as a result of this study are presented in Section 5.

SECTION 2

LABORATORY TEST MEASUREMENTS

The experimental apparatus, the materials tested, and the test procedures used by the Boeing Company to measure various material properties and the data resulting from these measurements are described below.

2.1 EXPERIMENTAL APPARATUS

Three experimental apparatus were used to make measurements: The Ohio State University (OSU) Combustion Analyzer, the National Bureau of Standards (NBS) Smoke Chamber, and the Boeing Burnthrough Apparatus. Colorimetric (Dräger) tubes were used to measure selected toxic gases. Although these tubes are not suitable as a primary method for quantitative analysis of combustion products, they have been shown to be an inexpensive method for identifying the presence of certain gases and were thus considered satisfactory for this study [1].

2.1.1 OSU Combustion Analyzer

The Combustion Analyzer apparatus developed at The Ohio State University [2] was used to determine flame spread rates, heat release rates, and smoke release rates as a function of heat flux incident on the material tested. A schematic diagram of the instrument is shown in Figure 2.1. While a specimen is being burned, air enters the bottom of the test chamber and exits out the top. Heat and smoke measurements are made on the exhaust gas from the chamber.

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[1] Constantine P. Sarkos, "Measurements of Toxic Gases and Smoke from Aircraft Cabin Interior Materials Using the NBS Smoke Chamber and Colorimetric Tubes", National Aviation Facilities Experimental Center, FAA-RD-76-7, March 1976.

[2] E. E. Smith, "Measuring Rate of Heat, Smoke, and Toxic Gas Release," Fire Technology 8, No. 3 (1972).

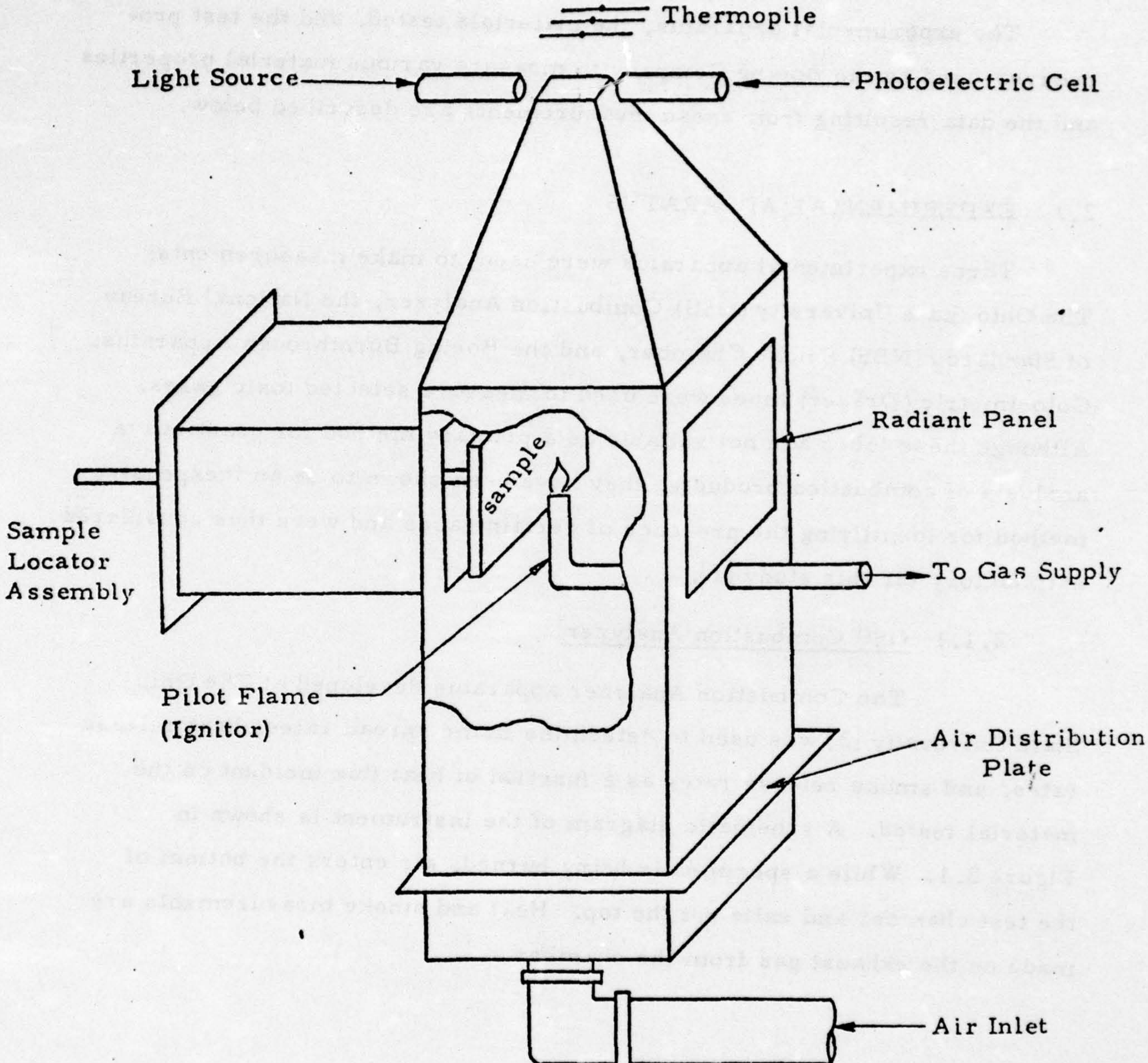


Figure 2.1 OSU Combustion Analyzer

Samples to be tested are mounted either vertically or horizontally and are subjected to a radiant heat flux generated from an electrically heated or gas-fired radiant panel. The heat flux level from the electric panel is adjustable to a maximum of about 3.5 W/cm^2, and that from the gas-fired panel to about 7.0 W/cm^2. A small pilot flame (12 Btu/min) is used to ignite the sample for tests in the flaming state. A further description of the OSU Combustion Analyzer can be found in Reference [2].

2.1.1.1 Heat Release Data

As the sample burns, heat is released that increases the stack gas temperature and increases thermopile voltage $v(t)$ which is recorded automatically. A typical recorder plot of the output voltage from the thermopile is shown in Figure 2.2. This increase is proportional to the heat release rate with proportionality constant k, so that heat release rate per unit area at time t is $k\ v(t)/A$ where A is the area of the test specimen. The total heat released is the heat release rate integrated over the total burning time of the sample.

2.1.1.2 Smoke Release Data

Smoke leaving the stack causes a photoelectric cell which is sensing the light transmitted across the stack width to decrease its output voltage. A typical recorder plot of the output voltage from the photoelectric cell is shown in Figure 2.3. This decrease is monotonically related to the light transmission, $T(t)$. A calibration using neutral density filters is employed to determine the relationship. The volume rate of flow of exhaust gases through the stack, $\dot{V}(t)$, is equal to the quantity $\dot{V}_o T_g(t)/T_{g_o}$, where $\dot{V}_o$ is the input flow rate of air, $T_g(t)$ the absolute exhaust gas temperature, and T_{g_o} the absolute input air temperature. The value of $\dot{V}_o$ for all tests was 85 ft^3/min. The rate of change of specific optical density (equivalent to smoke release rate) is then:

$$\dot{D}_s(t) = (AL)^{-1}\ \dot{V}(t) \log [100/T(t)]$$

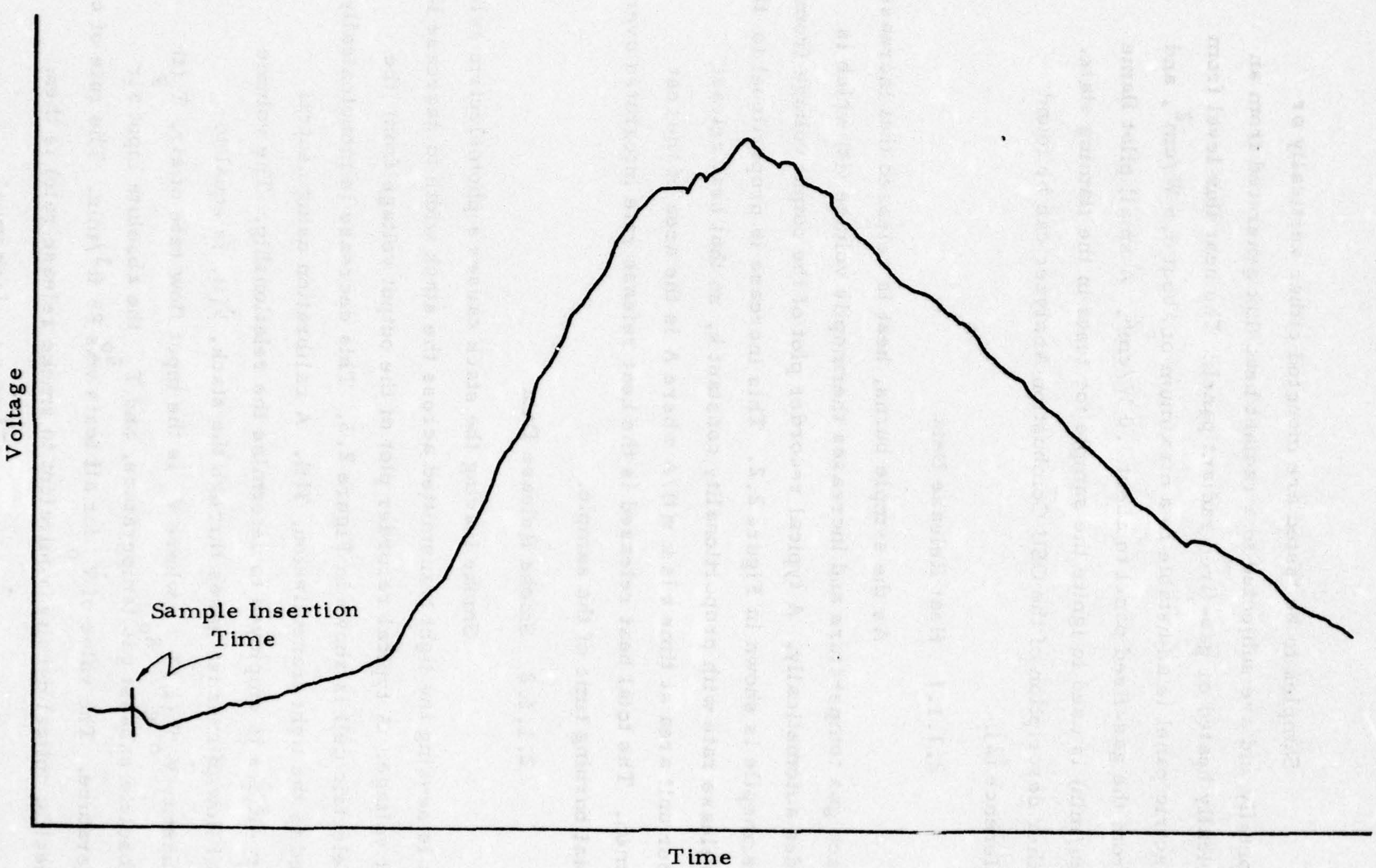


Figure 2.2 Typical Recorder Plot of the Output Voltage from the Thermopile on the OSU Combustion Analyzer

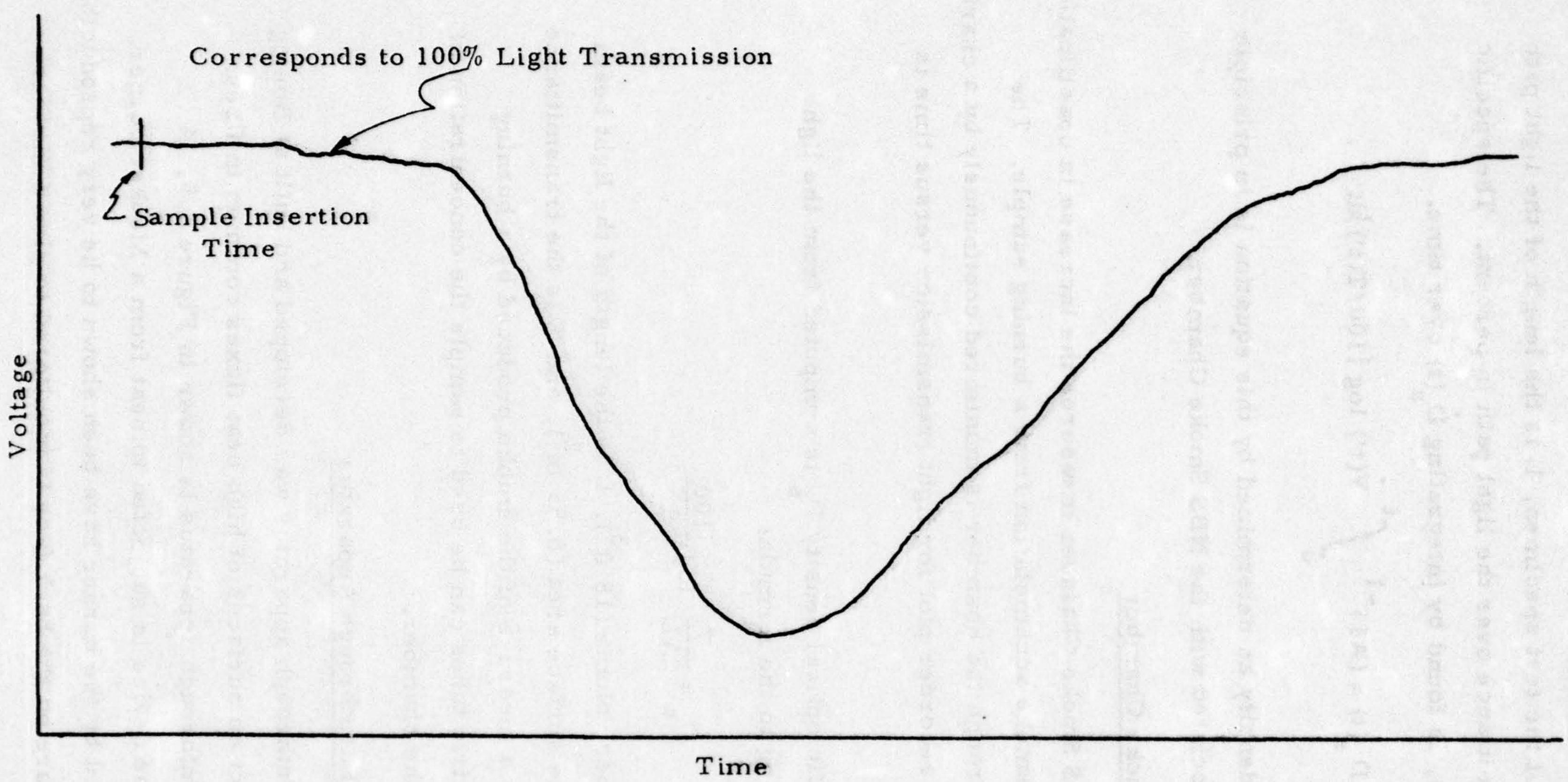


Figure 2.3 Typical Recorder Plot of the Output Voltage from the Photoelectric Cell on the OSU Combustion Analyzer

where A is the area of the test specimen, L is the length of the light path and T(t) is the transmittance over the light path in percent. The specific optical density, $D_s(t)$, is found by integrating $\dot{D}_s(t)$ over time.

$$D_s(t) = (AL)^{-1} \int_0^t \dot{V}(t') \log [100/T(t')] dt' \quad .$$

The specific optical density as determined by this equation is in principle the same as that associated with the NBS Smoke Chamber.

2.1.2 NBS Smoke Chamber

The NBS Smoke Chamber measures the increase in opacification in a chamber due to smoke accumulation from a burning sample. The light transmission through the chamber is monitored continuously by a chart recorder. A typical recorder plot for light transmission versus time is shown in Figure 2.4.

A specific optical density D_s is computed from the light transmission according to the formula:

$$D_s = \frac{V}{AL} \log \frac{100}{T}$$

where V is the chamber volume (18 ft^3), L is the length of the light beam (3 ft), A is the sample surface area (6.55 in^2), and T is the transmittance in percent. D_s gives a measure of the smoke produced by a burning specimen. Colorimetric tubes can be used to sample the concentration of toxic gas species in the chamber.

2.1.3 Boeing Burnthrough Apparatus

The burnthrough apparatus was developed and built at Boeing to determine the effect on surfaces of high heat fluxes common in fires. The design of the burnthrough apparatus is shown in Figure 2.5. A specimen placed in the device is subjected to heat from a Meeker burner. The conditions created by the burner have been shown to be very reproducible. The rise in temperature on the back face is monitored to give a measure

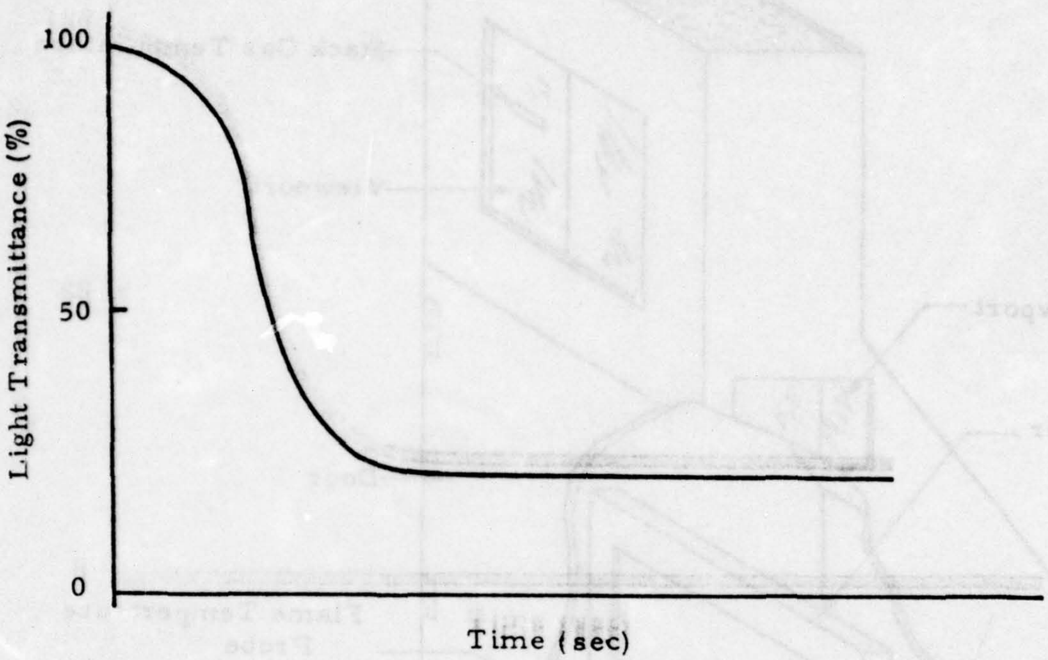


Figure 2.4 Light Transmission Versus Time from the NBS Smoke Chamber

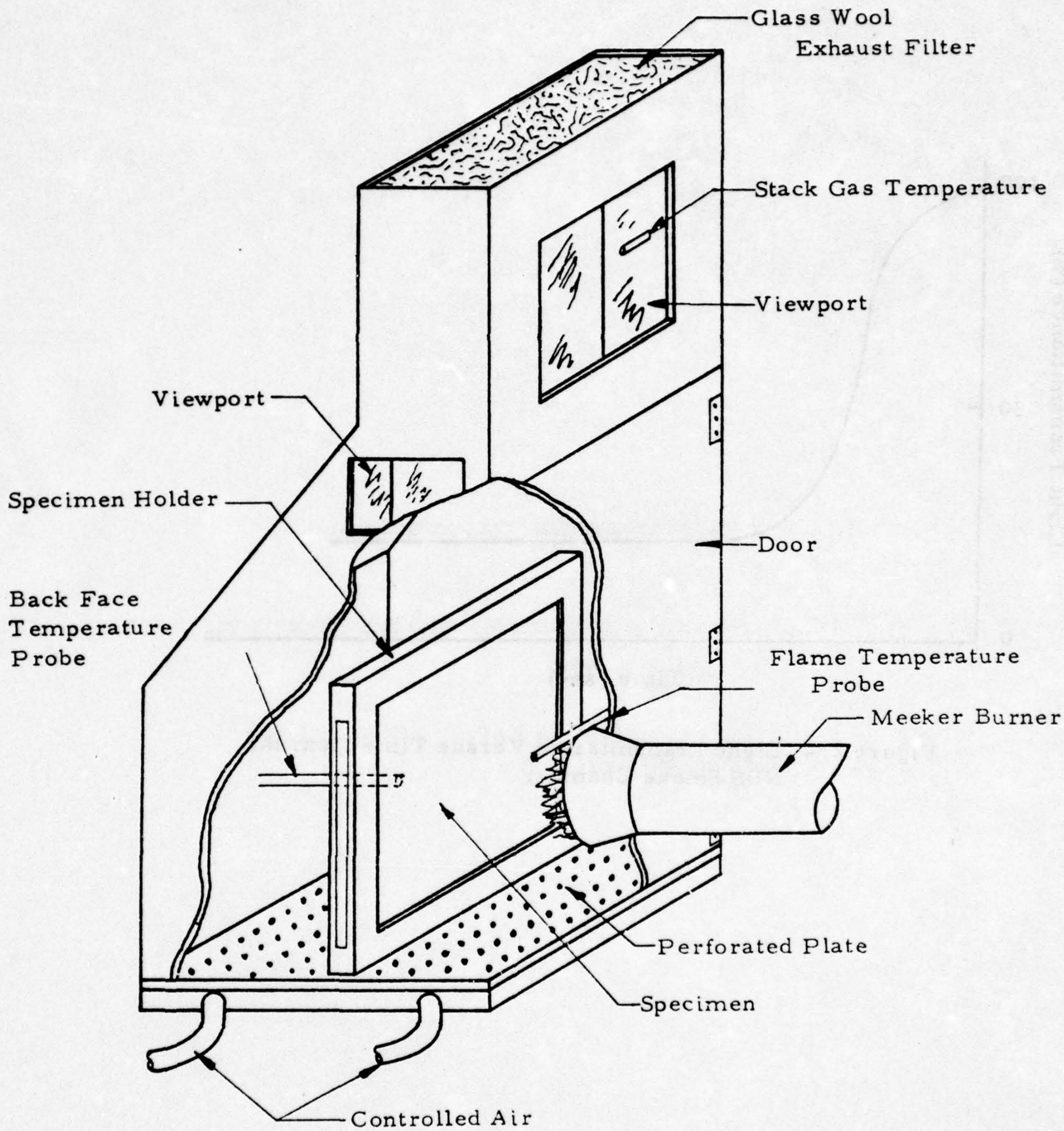


Figure 2.5 Boeing Burnthrough Apparatus

of how the material withstands direct fire exposure. A sudden, precipitous rise in back-face temperature indicates burnthrough has taken place. The temperature of the stack gases is monitored to provide a rough measure of the heat release rate and the total heat release.

2.1.4 Colorimetric Tubes

Colorimetric tubes, (such as Dräger tubes), were used for toxic gas analysis. Toxic gas species produced were determined by burning test specimens in the NBS Smoke Chamber at various heat fluxes (2.5, 5.0, and 7.5 W/cm^2). The gases in the chamber were measured with the colorimetric tubes at approximately their highest concentration. Results are expressed in parts per million, by volume. Significant toxic gases for which measurements were made were limited to CO, SO_2, HCl, HCN, and HF.

2.2 MATERIALS TESTED

Eighteen separate cabin interior materials were tested. These materials can be grouped into nine different usages in a typical wide-body aircraft cabin. Each material was tested in a vertical position, a horizontal position, or both, depending on its usage in the cabin. Table 2.1 lists the materials tested and indicates the position in which each was tested.

The carpet materials were tested with their pads. All the sidewall panels were of the same construction but different in color or printed pattern. The sidewall panel construction is shown in Figure 2.6. The window reveal and passenger service unit (PSU) are made of the same material. The stowage bin construction is shown in Figure 2.7. The ceiling panels were all of the construction shown in Figure 2.8. The seat upholstery materials tested were backed by a half inch polyether urethane foam pad.

TABLE 2.1
MATERIALS TESTED

Material No.	Material Usage	Material Description	Tested Vertically	Tested Horizontally
1	Carpet and Pad	wool, cut and loop		•
2	Carpet and Pad	wool, loop pile		•
3	Sidewall Panel	white background, printed letters (see Fig. 2.6)	•	
4	Sidewall Panel	yellow with geometric figure (see Fig. 2.6)	•	
5	Sidewall Panel	orange with geometric figure (see Fig. 2.6)	•	
6	Sidewall Panel	blue with geometric figure (see Fig. 2.6)	•	
7	Sidewall Panel	brown with wood grain pattern (see Fig. 2.6)	•	
8	Window Reveal, PSU	0.080 inch thick beige polycarbonate	•	•
9	Window Reveal, PSU	0.040 inch thick beige polycarbonate	•	•
10	Window Transparency	acrylic	•	
11	Stow Bin	cream colored (see Fig. 2.7)		•
12	Upper Ceiling Panel	(see Fig. 2.8)		•
13	Lower Ceiling Panel	(see Fig. 2.8)		•
14	Lower Ceiling Panel	brown, perforated (see Fig. 2.8)	•	•

TABLE 2.1 (Continued)

MATERIALS TESTED

Material No.	Material Usage	Material Description	Tested Vertically	Tested Horizontally
15	Seat Upholstery and Foam Pad	100% Nomex, zirconium treated, 0.5 inch foam pad	•	•
16	Seat Upholstery and Foam Pad	90% wool, 10% nylon, zirconium treated, 0.5 inch foam pad	•	•
17	Seat Upholstery and Foam Pad	100% wool, zirconium treated, 0.5 inch foam pad	•	•
18	Seat Cushion Foam Pad	0.5 inch thick polyether urethane	•	•

Cabin Side

.001 inch clear Tedlar

------Ink decorative pattern

.002 inch opaque Tedlar

1 ply type 181 fiberglass-epoxy (pre-impregnated)

1 ply type 120 fiberglass-epoxy (pre-impregnated)

Nomex honeycomb core; 0.125 inch cell, 0.25 inch thick, 3 lb/ft^3 density

2 ply type 120 fiberglass-epoxy (pre-impregnated)

Inner Wall Side

Figure 2.6 Sidewall Panel Construction

Cabin Side

.002 inch opaque Tedlar

1 ply type 181 fiberglass-epoxy
(pre-impregnated)

1 ply type 120 fiberglass-epoxy
(pre-impregnated)

Nomex honeycomb core; 0.25 inch cell,
0.25 inch thick; 1.5 lb/ft^3 density

1 ply type 181 fiberglass-epoxy
(pre-impregnated)

1 ply type 120 fiberglass-epoxy
(pre-impregnated)

.001 inch opaque Tedlar

Inner Wall Side

Figure 2.7 Stowage Bin Construction

Cabin Side

.002 inch opaque Tedlar

1 ply type 181 fiberglass-epoxy
(pre-impregnated)

1 ply type 120 fiberglass-epoxy
(pre-impregnated)

Nomex honeycomb core; 0.25 inch cell,
0.25 inch thick, 1.5 lb/ft^3 density

1 ply type 120 fiberglass-epoxy
(pre-impregnated)

Inner Wall Side

Figure 2.8 Ceiling Panel Construction

2.3 TEST MEASUREMENTS

Flame spread rates, heat release data, smoke release data and all but one (t_{pe}) of the time parameters identified in Section 1 were measured using the OSU Combustion Analyzer. A total of 31 data items were acquired from the Combustion Analyzer for each vertical specimen tested. A total of 19 data items were acquired for each horizontal specimen tested. The vertical specimens were six inches by six inches in size. The horizontal specimens were four inches by ten inches. Heat flux values were varied from 1.4 W/cm^2 to 6.0 W/cm^2. This range covers the heat flux values which materials are likely to experience in a typ.cal cabin fire. The various data items from the Combustion Analyzer and the manner in which they were determined are as follows.

Vertical Specimens

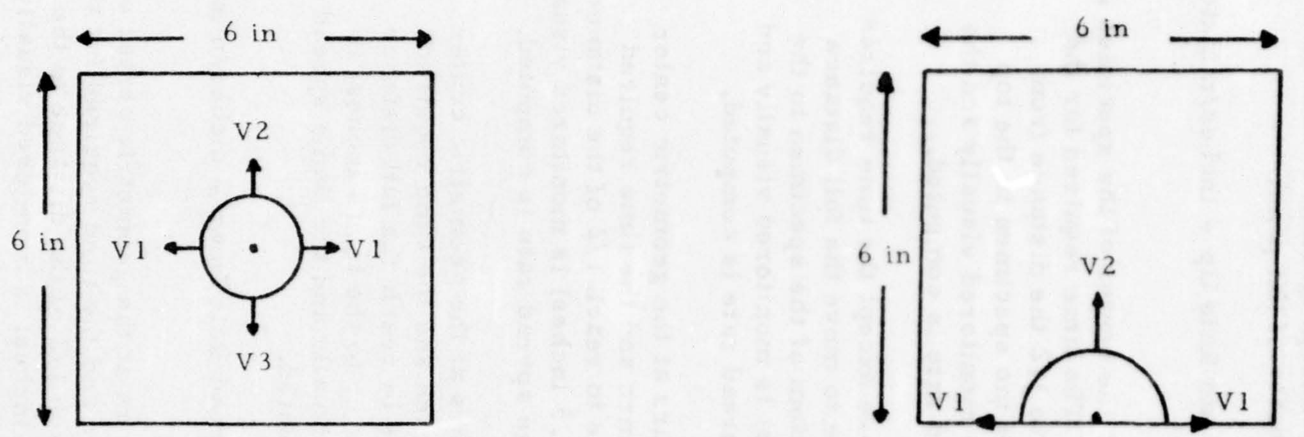
1. Horizontal Flame Spread Rate - inches/minute (see Figure 2.9)

V1A - Pilot ignition is at the center of the bottom of the specimen. The time after ignition required for the flame to move from the center to 1/3 the distance from the centerline to the right or left edge (1 inch) is monitored visually and the flame spread rate is computed.

V1B - Same as above except the time after ignition required for the flame to move 2/3 the distance from the centerline to the right or left edge (2 inches) is monitored visually and the flame spread rate is computed.

V1C - Same as above except the time after ignition required for the flame to move the full distance from the centerline to the right or left edge (3 inches) is monitored visually and the flame spread rate is computed.

V1D - Same as V1A except ignition occurs at the geometric center of the panel.



(a) Center-Center Ignition (b) Bottom-Center Ignition

Figure 2.9 Flame Spread Rates on a Vertical Specimen in the OSU Combustion Analyzer

V1E - Same as V1B except ignition occurs at the geometric center of the panel.

V1F - Same as V1C except ignition occurs at the geometric center of the panel.

2. Vertical Flame Spread Rate Up - inches/minute (see Figure 2.9)

V2A - Ignition is at the center of the specimen at the bottom. The time required for the flame to move 1/2 the distance from the bottom of the specimen to the top (3 inches) is monitored visually and the flame spread rate is computed.

V2B - Same as above except the time required for the flame to move the full distance from the bottom of the specimen to the top (6 inches) is monitored visually and the flame spread rate is computed.

V2C - Ignition occurs at the geometric center of the specimen and the time required for the flame to reach 1/2 of the distance to the top (1.5 inches) is monitored visually and the flame spread rate is computed.

V2D - Ignition occurs at the geometric center of the specimen and the time required for the flame to reach the full distance from the center to the top (3 inches) is monitored visually and the flame spread rate is computed.

3. Vertical Flame Spread Rate Down - inches/minute (see Figure 2.9)

V3A - Ignition occurs at the geometric center of the specimen and the time required for the flame to reach 1/2 of the distance to the bottom (1.5 inches) is monitored visually and the flame spread rate is computed.

V3B - Ignition occurs at the geometric center of the specimen and the time required for the flame to reach the full distance to the bottom (3 inches) is monitored visually and the flame spread rate is computed.

4. Heat Release Data

V4A - The maximum heat release rate per unit area is reported in Btu/($ft^2 \cdot$ min).

V4A1 - bottom-center ignition

V4A2 - center-center ignition

V4A3 - no piloted ignition

V4B - The total heat release is reported in Btu/ft^2.

V4B1 - bottom-center ignition

V4B2 - center-center ignition

V4B3 - no piloted ignition

5. Smoke Release Data

V5A - The maximum value of the specific optical density, D_s, which is a dimensionless quality, is reported.

V5A1 - bottom-center ignition

V5A2 - center-center ignition

V5A3 - no piloted ignition

V5B - The maximum time rate of change of D_s in units of per minute is reported.

V5B1 - bottom-center ignition

V5B2 - center-center ignition

V5B3 - no piloted ignition

6. Time to Flame - minutes

V6A - The elapsed time after the sample is inserted before ignition occurs using a center-center pilot flame is reported.

V6B - Same as above except with no pilot flame.

7. Time to Self Extinguishment After Ignition - minutes

V7A - The time which elapses between piloted ignition at the bottom center and self extinguishment is reported.

V7B - Same as V7A, except the ignition is at center-center.

V7C - The time which elapses between auto ignition and self extinguishment is reported.

8. Time to Smolder (only exposures with no piloted ignition) - minutes

V8 - The time which elapses between sample insertion and the onset of smoldering monitored visually as a blackening or darkening of the sample surface is reported.

9. Time to Self Extinguishment After Smoldering Begins (only exposures with no piloted ignition) - minutes

V9 - The time which elapses between the onset of smoldering and the end of smoldering, monitored visually, is reported.

Horizontal Specimens

1. Horizontal Flame Spread Rate - inches/minute (see Figure 2.10)

H1A - Pilot ignition is at the geometric center of the specimen. The time required for the flame to move from the center to 1/2 the distance to the short side (1 inch) is monitored visually and the flame spread rate is computed.

H1B - Same as above except the time for the flame to move the entire distance to the short side (2 inches) is monitored visually and the flame spread rate is computed.

H1C - Same as above except the time for the flame to move half the distance from the center to the long side (2.5 inches) is monitored visually and the flame spread rate is computed.

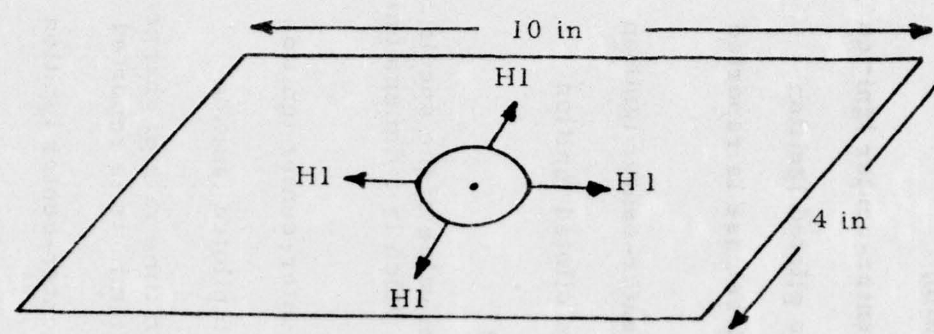


Figure 2.10 Flame Spread Rate on a Horizontal Specimen in the OSU Combustion Analyzer

H1D - Same as above except the time for the flame to move all the way to the long side is monitored visually and the flame spread rate is computed.

2. Heat Release Data

H2A - The maximum heat release rate per unit area in Btu/($ft^2 \cdot$ min)

H2A1 - center-center ignition

H2A2 - no piloted ignition

H2B - The total heat release is reported in Btu/ft^2.

H2B1 - center-center ignition

H2B2 - no piloted ignition

3. Smoke Release Data

H3A - The maximum value of the specific optical density, D_s, which is a dimensionless quantity is reported.

H3A1 - center-center ignition

H3A2 - no piloted ignition

H3B - The maximum time rate of change of D_s in units of per minute is reported

H3B1 - center-center ignition

H3B2 - no piloted ignition

4. Time to Flame - minutes

H4A - The time elapsed after the sample is inserted before ignition occurred for center-center pilot flame is reported.

H4B - Same as above except with no pilot flame.

5. Time to Self Extinguishment After Ignition - minutes

H5A - The time which elapses between piloted ignition at the center of the sample and self extinguishment is reported.

H5B - The time which elapses between auto ignition and self extinguishment is reported.

6. Time to Smolder (only exposures with no piloted ignition) - minutes

H6 - The time which elapses between sample insertion and the onset of smoldering monitored visually as a blackening or darkening of the sample surface is reported.

7. Time to Self Extinguishment After Smoldering Begins (only exposures with no piloted ignition) - minutes

H7 - The time which elapses between the onset of smoldering and the end of smoldering, monitored visually, is reported.

The measurements from the OSU Combustion Analyzer are presented in Appendix A in Tables A-1 through A-25. The data items are labeled by the above symbols. In most cases three specimens of each material were tested. The results of each test and the average value for each data item measured are presented in the tables.

The Boeing Burnthrough Apparatus was used to measure one time parameter, the time to cease smoldering when the external heat flux is removed. It was more convenient to use the burnthrough apparatus rather than the OSU Combustion Analyzer for this data item since the Combustion Analyzer would have had to be modified for this measurement. The data was measured as follows.

V10 - H8 A four inch by four inch specimen is subjected to the heat from a Meeker burner until it begins to smolder. (The heat flux at the center of the specimen is approximately 10 W/cm^2). The burner is then extinguished and the time for the specimen to cease smoldering is monitored visually and is reported in minutes.

For vertical specimens this item is symbolized by V10 in Tables A-1 through A-25. For horizontal specimens it is symbolized by H8.

The NBS Smoke Chamber was used to measure CO, HCl, HCN, SO_2, and HF gas yields at three heat flux levels (2.5, 5.0, and 7.5 W/cm^2) for materials 1, 2, 7, 8, 10, 13, 14, 15, 16, and 17 and also for a sidewall panel similar to materials 3, 4, 5, 6, and 7. Toxic gases concentrations were measured at their approximate maximum using colorimetric tubes. These data along with smoke density data are presented in Tables A-26 through A-28.

The laboratory test data was analyzed to determine values for the various material characteristics listed in Section I. This analysis is described in the next section.

SECTION 3

ANALYSIS OF THE LABORATORY TEST DATA

The laboratory test data discussed in Section 2 was analyzed to provide estimates of the material flammability and combustion toxicity properties for a representative section of a wide-body aircraft cabin. The manner in which each of the properties of interest were estimated is as follows.

f_h - The average value of V1C was used for the horizontal flame spread rate for a vertical specimen. The average value of H1D was used for a horizontal specimen. Thus, the rate used is based on flame travel from the center line of the specimen to the edge. Examination of the data showed that V1C and H1D exhibited less variability for a given material and heat flux than other measures of horizontal flame spread rate. The rates were converted from inches per minute to feet per second for use in the DACFIR Model.

f_u - The average value of V2A was used for the upward flame spread rate. Thus, the rate is based on flame travel from the bottom of the specimen to halfway to the top. Examination of the data indicated that this estimate of the rate contained the least variability. The rate was converted from inches per minute to feet per second for use in the DACFIR Model.

f_d - The average value of V3B was used for the downward flame spread rate. The rate is based on flame travel from the center of the specimen to the bottom edge. Examination of the data indicated that this estimate of the rate contained the least variability. The rate was converted from inches per minute to feet per second for use in the DACFIR Model.

t_f - The average value of V6A was used to estimate the time to flame for a vertical specimen. The average value of H4A was used for a horizontal specimen.

Both these values correspond to ignition at the center of the specimen. The time was converted from minutes to seconds for use in the DACFIR Model.

t_{fc} - The average value of V7B was used to estimate the time to become charred due to flaming combustion for a vertical specimen. The average value of H5A was used for a horizontal specimen. These values correspond to ignition at the center of the specimen. The time was converted from minutes to seconds for use in the DACFIR Model.

t_p - The average value of V8 was used to estimate the time to smolder for a vertical specimen. The average value of H6 was used for a horizontal specimen. The time was converted from minutes to seconds for use in the DACFIR Model.

t_{pc} - The average values of V9 was used to estimate the time to become charred due to smoldering for a vertical specimen. The average value of H7 was used for a horizontal specimen. The time was converted from minutes to seconds for use in the DACFIR Model.

t_{pe} - The average value of V10 was used to estimate the time to cease smoldering once the heat flux has been reduced for a vertical specimen. The average value of H8 was used for a horizontal specimen. The time was converted from minutes to seconds for use in the DACFIR Model.

r_h - The heat release rate per unit area was estimated by dividing the average value of V4B2 (the total heat released per unit area) by the average value of V7B (the time to burn) for a vertical specimen. The heat release rate per unit area for a horizontal specimen was found by dividing the average value of H2B1 by the average value of H5A. The rate was converted from British thermal units per square foot per minute to British thermal units per foot squared per second.

r_{sf} - The smoke release rate per unit area for a flaming condition was found by dividing the average value of V5B2 (the total smoke released per unit area) by the

average value of V7B (the time to burn) for a vertical specimen. The smoke release rate per unit area for a flaming condition was found by dividing the average value of H3A1 by the average value of H5A for a horizontal specimen. The smoke release rate was derived in units of "particles" per foot squared per second. The number of "particles" of smoke generated per square foot of the specimen is found by dividing the specific optical density, D_s, by 0.04576. The derivation of this conversion factor is presented in Appendix C. One "particle" of smoke is defined to be that amount of smoke which if contained in a volume of one cubic foot would reduce the transmission of light by 10% over a path length of one foot.

r_{ss} - The smoke release rate per unit area for a smoldering condition was found for a vertical specimen by dividing V5A3 (the total smoke released per unit area) by V9 (the time from the onset of smoldering to the end of smoldering) when a "no" is entered for V6B (the time to flame). The smoke release rate per unit area for a smoldering condition was found for a horizontal specimen by dividing H3A2 by H7 when a "no" is entered for H4B. The unit of smoke was converted from specific optical density to "particles" per square foot by the above conversion factor. The rate was converted from per minute to per second.

$r_f(i)$ - For a vertical specimen, the toxic gas release rate for the i^{th} toxic gas for a flaming condition was found by dividing the approximate maximum concentration in the NBS Smoke Chamber by V7B (the time to burn). For a horizontal specimen, the toxic gas release rate for the i^{th} toxic gas for a flaming condition was found by dividing the approximate maximum concentration in the NBS Smoke Chamber by H5A. Data was available on five toxic gases (HCN, HCl, HF, CO, and SO_2). The amount in pounds released per unit area was found by the equation

$$R'(lbs/ft^2) = 1.01805 \times 10^{-6} C\ (ppm)\ W_G$$

where C is the concentration in parts per million (ppm) and W_G is the molecular weight of the gas (W_G = 27 for HCN, 36.5 for HCl, 20 for HF, 28 for CO, and 64 for SO_2). R' was divided by the time to burn (V7B or H5A) to provide the rate in pounds per square foot per second. The derivation of the above relationship is shown in Appendix D.

$r_s(i)$ - No data was generated for the release rates per unit area of toxic gases during the smoldering condition.

The above calculations were performed for each material and each heat flux for which data were reported. The resulting values for each material are presented in Appendix B in Tables B.1 through B.22. When laboratory test data was recorded for more than one specimen of a given material, the mean value and the upper and lower limits were determined for the flammability property. These values are presented in the Tables in Appendix B.

There was insufficient data to fully define some of the flammability properties as a function of heat flux. Therefore, interpolation, extrapolation, and estimation was needed to generate some of the materials data needed for input into the DACFIR Model. The development of these tables and curves of the various properties as a function of heat flux are presented in the next section.

SECTION 4

MATERIAL PROPERTIES INPUT DATA FOR THE DAYTON AIRCRAFT CABIN FIRE MODEL

The purpose of the laboratory test program was to provide representative input data to the DACFIR Model. These data are of two types: properties associated with a flaming combustion state and properties associated with a smoldering combustion state. The flaming state properties vary with incident heat flux, whereas the smoldering state properties correspond to a particular heat flux level which is associated with the smoldering condition.

Representative material properties data was derived by examining the data discussed in Section 3. The DACFIR Model requires data for seven interior structures.

1. Carpet
2. Sidewall Panel
3. Window Reveal and Transparency
4. Passenger Service Unit (PSU)
5. Stowage Bin
6. Ceiling Panel
7. Seat Upholstery and Padding

The flaming state properties for which data was needed are flame spread rates (f_h, f_u, and f_d); smoke release rate per unit area (r_{sf}); heat release rate per unit area (r_h); toxic gas release rates per unit area [$r_f(HCN)$, $r_f(HCl)$, $r_f(SO_2)$, $r_f(HF)$, and $r_f(CO)$]; the time of flame (t_f); and the time to become charred from flaming combustion (t_{fc}). Tables 4.1 through 4.12 present the data generated for each of these parameters as a function of heat flux for each of the seven interior structures listed above. (It should be noted that the DACFIR Model will handle nine toxic gases; however, measurements were made only for HCN, HCl, HF, CO, and SO_2.) The

TABLE 4.1

INPUT DATA FOR DACFIR MODEL

HORIZONTAL FLAME SPREAD RATE (f_h -ft/sec)

AS A FUNCTION OF HEAT FLUX [q- Btu/(ft^2 · sec)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.30	1.23	1.94	2.82	3.96	4.30
	f_h	0.0	0.0170	0.0464	0.1390	0.4170	0.5000
Sidewall	q	0.00	1.00	2.20	3.08	4.00	5.00
	f_h	0.0	0.0	0.0093	0.0181	0.0275	0.0380
Window Reveal & Transparency	q	1.00	2.20	3.08	4.41	4.60	5.00
	f_h	0.0	0.0020	0.0042	0.0083	0.0094	0.0120
Passenger Service Unit	q	1.32	2.20	3.08	4.41	4.60	5.00
	f_h	0.0	0.0018	0.0034	0.0075	0.0086	0.0110
Stowage Bin	q	0.00	1.32	2.82	3.08	4.00	5.00
	f_h	0.0	0.0	0.0155	0.0181	0.0275	0.0380
Ceiling	q	0.00	1.00	1.94	2.82	3.96	4.20
	f_h	0.0	0.0	0.0106	0.0213	0.0415	0.0450
Seats	q	0.50	1.23	1.94	3.50	4.00	5.00
	f_h	0.0	0.0040	0.0115	0.0660	0.0970	0.1700

TABLE 4.2

INPUT DATA FOR DACFIR MODEL
VERTICALLY UPWARD FLAME SPREAD RATE (f_u-ft/sec) AS A FUNCTION OF HEAT FLUX [q-Btu/($ft^2 \cdot$ sec)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	Not Used in a Vertical Orientation					
	f_u						
Sidewall	q	0.40	1.00	2.20	3.08	3.50	4.00
	f_u	0.0	0.0	0.0192	0.0300	0.0350	0.0410
Window Reveal & Transparency	q	0.00	1.00	2.00	3.08	4.41	5.00
	f_u	0.0	0.0	0.0030	0.0065	0.0133	0.0175
Passenger Service Unit	q	0.00	1.32	2.20	3.08	4.41	5.00
	f_u	0.0	0.0	0.0035	0.0044	0.0113	0.0150
Stowage Bin (sidewall values used)	q	0.0	1.00	2.20	3.08	3.50	4.00
	f_u	0.0	0.0	0.0192	0.0300	0.0350	0.0410
Ceiling	q	Not Used in a Vertical Orientation					
	f_u						
Seats (1.5xf_h used)	q	0.50	1.23	1.94	3.00	3.96	5.00
	f_u	0.0	0.0060	0.0173	0.0450	0.0834	0.1500

TABLE 4.3

INPUT DATA FOR DACFIR MODEL
VERTICALLY DOWNWARD FLAME SPREAD RATE (f_d-ft/sec)
AS A FUNCTION OF HEAT FLUX [q- Btu/(ft^2 · sec)]

Interior Structure	Variable	Table Entry Number					
		1	2	3	4	5	6
Carpet	q	Not Used in a Vertical Orientation					
	f_d						
Sidewall	q	0.00	1.00	2.20	3.08	3.50	4.00
	f_d	0.0	0.0	0.0078	0.0187	0.0240	0.0305
Window Reveal & Transparency	q	0.00	1.00	2.20	3.08	4.41	5.00
	f_d	0.0	0.0	0.0016	0.0038	0.0083	0.0011
Passenger Service Unit	q	0.00	1.32	2.20	3.08	4.41	5.00
	f_d	0.0	0.0	0.0014	0.0034	0.0075	0.0097
Stowage Bin (sidewall values used)	q	0.00	1.00	2.20	3.08	3.50	4.00
	f_d	0.0	0.0	0.0078	0.0187	0.0240	0.0305
Ceiling	q	Not Used in a Vertical Orientation					
	f_d						
Seats (0.8xf_h used)	q	0.50	1.23	1.94	3.00	3.96	5.00
	f_d	0.0	0.0032	0.0092	0.0240	0.0445	0.0800

TABLE 4.4

INPUT DATA FOR DACFIR MODEL
TIME TO FLAME (t_f-sec)
AS A FUNCTION OF HEAT FLUX [q-Btu/(ft^2·sec)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet (estimated from t_p)	q	0.00	1.00	2.00	3.00	4.00	50.00
	t_f	9000.00	10.00	5.00	2.00	1.00	0.00
Sidewall	q	0.00	0.50	2.20	3.08	6.00	50.00
	t_f	9000.00	5.00	1.92	1.44	0.50	0.00
Window Reveal & Transparency (reveal values used)	q	0.00	1.00	2.20	3.08	4.41	50.00
	t_f	9000.00	50.00	21.60	10.8	2.40	0.00
Passenger Service Unit	q	0.00	1.00	2.20	3.08	4.41	50.00
	t_f	9000.00	50.00	21.60	10.80	2.40	0.00
Stowage Bin (sidewall values used)	q	0.00	1.00	1.94	2.82	5.00	50.00
	t_f	9000.00	10.00	2.40	1.20	0.10	0.00
Ceiling	q	0.00	0.50	2.20	3.08	6.00	50.00
	t_f	9000.0	5.00	1.92	1.44	0.50	0.00
Seats	q	0.00	1.00	2.20	4.00	8.00	50.00
	t_f	9000.00	10.0	4.00	1.00	0.50	0.00

TABLE 4.5

INPUT DATA FOR DACFIR MODEL
TIME TO CHAR FROM THE FLAMING STATE (t_{fc} -sec)
AS A FUNCTION OF HEAT FLUX [q-Btu/(ft^2·sec)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.00	1.00	1.94	2.82	5.00	50.00
	t_{fc}	9000.0	930.0	632.00	326.00	60.00	10.00
Sidewall	q	0.00	1.00	2.20	3.08	4.41	50.00
	t_{fc}	9000.0	75.0	51.36	42.36	29.40	5.00
Window Reveal & Transparency (used reveal data times 3/4)	q	0.00	1.00	2.00	3.00	4.41	50.00
	t_{fc}	9000.0	750.0	525.00	395.00	265.00	15.00
Passenger Service Unit	q	0.00	1.00	2.00	3.00	4.41	50.00
	t_{fc}	9000.0	1000.00	700.00	550.00	355.20	20.00
Stowage Bin (used side-wall values times 3)	q	0.00	1.00	2.20	3.08	4.41	50.00
	t_{fc}	9000.0	225.00	153.00	128.40	87.00	15.00
Ceiling (sidewall values used)	q	0.00	1.00	2.20	3.08	4.41	50.00
	t_{fc}	9000.0	75.0	51.36	42.36	29.40	5.00
Seats	q	0.00	1.23	1.94	2.82	4.41	50.00
	t_{fc}	9000.0	720.0	720.0	720.0	720.0	150.00

TABLE 4.6

INPUT DATA FOR DACFIR MODEL
HEAT RELEASE RATE PER UNIT AREA [r_h-Btu/(ft^2·sec)]
AS A FUNCTION OF HEAT FLUX [q-Btu/(ft^2·sec)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.00	0.40	1.94	2.82	5.00	6.00
	r_h	0.0	0.0	3.33	7.08	10.00	10.40
Sidewall	q	0.00	0.50	2.20	3.08	4.50	5.00
	r_h	0.0	0.0	2.75	4.42	6.00	6.30
Window Reveal & Transparency (transparency data used)	q	0.00	0.40	2.20	4.41	5.00	6.00
	r_h	0.0	0.0	7.67	11.61	11.61	11.61
Passenger Service Unit (used window transparency data)	q	0.00	0.40	2.20	4.41	5.00	6.00
	r_h	0.0	0.0	7.67	11.61	11.61	11.61
Stowage Bin	q	0.00	0.40	2.82	4.40	5.00	6.00
	r_h	0.0	0.0	5.43	8.00	8.45	9.00
Ceiling	q	0.20	0.40	1.23	1.94	2.60	3.90
	r_h	0.0	0.30	2.78	6.31	8.10	9.95
Seats	q	0.0	0.20	1.23	1.94	4.00	5.00
	r_h	0.0	0.0	2.03	2.59	3.20	3.20

TABLE 4.7

INPUT DATA FOR DACFIR MODEL

SMOKE RELEASE RATE PER UNIT AREA IN THE FLAMING STATE

[r_{sf}-part/($ft^2 \cdot sec$)] AS A FUNCTION OF HEAT FLUX [q-Btu/($ft^2 \cdot sec$)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.00	0.40	1.94	2.82	4.00	5.00
	r_{sf}	0.0	1.00	18.18	35.60	45.00	47.50
Sidewall	q	0.00	0.50	2.20	3.08	4.00	5.00
	r_{sf}	0.0	0.0	23.15	59.23	90.00	98.00
Window Reveal & Transparency	q	0.00	0.40	2.20	4.41	5.00	6.00
	r_{sf}	0.0	0.0	37.29	55.00	55.00	55.00
Passenger Service Unit	q	0.00	0.40	2.20	4.41	5.00	6.00
	r_{sf}	0.0	0.0	37.29	70.00	73.00	77.50
Stowage Bin (used sidewall values)	q	0.00	0.50	2.20	3.08	4.00	5.00
	r_{sf}	0.0	0.0	23.15	59.23	90.00	98.00
Ceiling	q	0.20	0.40	1.23	1.63	1.94	2.80
	r_{sf}	0.0	5.00	46.74	73.00	83.85	99.00
Seats	q	0.20	1.23	1.94	2.82	3.96	5.00
	r_{sf}	0.0	10.25	17.06	17.89	7.09	7.09

TABLE 4.8

INPUT DATA FOR DACFIR MODEL
RELEASE RATE PER UNIT AREA OF HCN IN THE FLAMING STATE
[r_f(HCN)-lb x 10^{-6}/(ft^2 · sec)] AS A FUNCTION OF HEAT FLUX
[q-Btu/(ft^2 · sec)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.00	0.40	2.20	3.18	4.41	6.61
	r_f(HCN)	0.0	0.0	3.9	5.6	6.2	5.6
Sidewall	q	0.00	0.50	2.20	4.41	5.70	6.61
	r_f(HCN)	0.0	0.0	0.5	1.8	4.6	8.7
Window Reveal & Transparency	q	0.00	1.00	2.20	4.41	6.00	6.61
	r_f(HCN)	0.0	0.0	0.0	0.0	0.1	0.2
Passenger Service Unit	q	0.00	1.00	2.20	4.41	5.40	6.61
	r_f(HCN)	0.0	0.0	0.0	0.1	0.1	0.0
Stowage Bin	q	0.00	0.50	2.20	4.41	5.56	6.61
	r_f(HCN)	0.0	0.0	0.1	0.6	1.4	2.9
Ceiling	q	0.00	0.20	2.20	3.20	4.41	6.61
	r_f(HCN)	0.0	0.0	1.0	3.0	8.3	18.4
Seats	q	0.00	0.20	2.20	2.8	4.41	6.61
	r_f(HCN)	0.0	0.0	3.7	3.9	3.4	1.7

TABLE 4.9

INPUT DATA FOR DACFIR MODEL
RELEASE RATE PER UNIT AREA OF HCl IN THE FLAMING STATE
[r_f(HCl)-lb x 10^{-6}/(ft^2 · sec)] AS A FUNCTION OF HEAT FLUX
[q-Btu/(ft^2 · sec)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.00	2.20	3.50	4.41	5.06	6.61
	r_f(HCl)	0.0	8.5	30.0	40.4	30.0	0.0
Sidewall	q	0.00	0.50	2.20	3.10	4.41	6.61
	r_f(HCl)	0.0	0.0	25.2	34.0	35.3	0.0
Window Reveal & Transparency	q	0.00	0.40	2.20	3.30	4.41	6.61
	r_f(HCl)	0.0	0.0	3.7	8.5	9.8	0.0
Passenger Service Unit	q	0.00	0.40	2.20	3.30	4.41	6.61
	r_f(HCl)	0.0	0.0	1.1	1.8	2.0	0.0
Stowage Bin	q	0.00	0.40	2.20	3.00	4.41	6.61
	r_f(HCl)	0.0	0.0	8.4	11.0	11.9	0.0
Ceiling	q	0.20	2.20	3.60	4.41	4.90	6.61
	r_f(HCl)	0.0	13.0	28.5	31.5	28.0	3.9
Seats	q	0.00	0.20	2.20	3.10	4.41	6.61
	r_f(HCl)	0.0	0.0	5.1	10.0	11.7	0.0

TABLE 4.10

INPUT DATA FOR DACFIR MODEL

RELEASE RATE PER UNIT AREA OF HF IN THE FLAMING STATE

$[r_f(HF)\text{-lb} \times 10^{-6}/(ft^2 \cdot sec)]$ AS A FUNCTION OF HEAT FLUX

$[q\text{-}Btu/(ft^2 \cdot sec)]$

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.00	1.00	2.20	4.41	5.00	6.61
	$r_f(HF)$	0.0	0.0	0.0	0.0	0.0	0.0
Sidewall	q	0.50	2.20	3.20	4.41	5.60	6.61
	$r_f(HF)$	0.0	63.2	80.0	82.8	62.5	9.3
Window Reveal & Transparency	q	0.00	1.50	2.20	4.41	5.00	6.61
	$r_f(HF)$	0.0	0.0	2.0	0.0	0.0	0.0
Passenger Service Unit	q	0.0	1.50	2.20	4.41	5.00	6.61
	$r_f(HF)$	0.0	0.0	1.5	0.0	0.0	0.0
Stowage Bin	q	0.50	2.20	3.30	4.41	5.60	6.61
	$r_f(HF)$	0.0	21.2	27.0	28.0	20.0	3.1
Ceiling	q	0.20	2.20	3.90	4.41	5.00	6.61
	$r_f(HF)$	0.0	31.6	195.0	207.1	175.0	5.7
Seats	q	0.00	1.00	2.20	4.41	5.00	6.61
	$r_f(HF)$	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4.11

INPUT DATA FOR DACFIR MODEL
RELEASE RATE PER UNIT AREA OF CO IN THE FLAMING STATE
[r_f(CO)-lb x 10^{-6}/(ft^2 · sec)] AS A FUNCTION OF HEAT FLUX
[q-Btu/(ft^2 · sec)]

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.50	2.20	3.70	4.41	5.00	6.61
	r_f(CO)	0.0	24.6	200.0	259.0	270.0	244.8
Sidewall	q	0.50	2.20	3.30	4.41	5.00	6.61
	r_f(CO)	0.0	208.0	170.0	92.0	150.0	631.6
Window Reveal & Transparency	q	0.40	2.20	3.70	4.41	5.40	6.61
	r_f(CO)	0.0	87.2	240.0	268.8	290.0	281.8
Passenger Service Unit	q	0.40	2.20	3.40	4.41	5.20	6.61
	r_f(CO)	0.0	0.0	70.0	160.4	180.0	168.1
Stowage Bin	q	0.50	2.20	3.00	4.41	4.90	6.61
	r_f(CO)	0.0	69.8	65.0	31.1	50.0	213.2
Ceiling	q	0.20	2.20	3.84	4.41	5.32	6.61
	r_f(CO)	0.0	305.1	800.0	872.4	800.0	505.3
Seats	q	0.20	2.20	3.40	4.41	5.40	6.61
	r_f(CO)	0.0	78.7	103.0	105.2	110.0	151.8

TABLE 4.12

INPUT DATA FOR DACFIR MODEL

RELEASE RATE PER UNIT AREA OF SO_2 IN THE FLAMING STATE

$[r_f(SO_2)\text{-lb} \times 10^{-6}/(\text{ft}^2 \cdot \text{sec})]$ AS A FUNCTION OF HEAT FLUX

$[q\text{-Btu}/(\text{ft}^2 \cdot \text{sec})]$

Interior Structure	Variable	Table Entry Number 1	2	3	4	5	6
Carpet	q	0.00	2.20	3.50	4.41	5.30	6.61
	$r_f(SO_2)$	0.0	31.2	90.0	118.3	100.0	67.1
Sidewall	q	0.00	1.00	2.00	3.00	4.00	5.00
	$r_f(SO_2)$	0.0	0.0	0.0	0.0	0.0	0.0
Window Reveal & Transparency	q	0.00	1.00	2.00	3.00	4.00	5.00
	$r_f(SO_2)$	0.0	0.0	0.0	0.0	0.0	0.0
Passenger Service Unit	q	0.00	1.00	2.00	3.00	4.00	5.00
	$r_f(SO_2)$	0.0	0.0	0.0	0.0	0.0	0.0
Stowage Bin	q	0.00	1.00	2.00	3.00	4.00	5.00
	$r_f(SO_2)$	0.0	0.0	0.0	0.0	0.0	0.0
Ceiling	q	0.00	1.00	2.00	3.00	4.00	5.00
	$r_f(SO_2)$	0.0	0.0	0.0	0.0	0.0	0.0
Seats	q	0.00	1.00	2.00	3.00	4.00	5.00
	$r_f(SO_2)$	0.0	0.0	0.0	0.0	0.0	0.0

smoldering state properties for which data was needed include the heat flux (q_p) at which smoldering is induced within a few seconds (less than 20 seconds); smoke release rate per unit area (r_{ss}); toxic gas release rates per unit area [r_s(HCN), r_s(HCl), r_s(HF), $r_s(SO_2)$, and $r_s(CO_2)$]; time to begin smoldering (t_p); and time to become charred from smoldering (t_{pc}). Values for each of these parameters are presented in Table 4.13 for the seven interior structures listed above. In the DACFIR Model, the time to cease smoldering (t_{pe}) when the heat flux is reduced below q_p is assumed to be a function of the reduced heat flux level. However, the variation of t_{pe} with heat flux could not be determined from the laboratory test data since the heat flux was always reduced to zero rather than some intermediate value between zero and q_p. The value of t_{pe} corresponding to a reduction of the heat flux to zero is shown in Table 4.13.

The data in Tables 4.1 through 4.13 was derived based on the laboratory test data for the following materials:

Carpet - Material No. 1

Sidewall Panel - Average Values for Material Nos. 3, 4, 5, 6, and 7

Window Reveal and Transparency - Average Values for Material Nos. 8 (Vertical Specimen) and 10

Passenger Service Unit - Material No. 8

Stowage Bin - Material No. 11

Ceiling Panel - Material No. 12

Seat Upholstery and Padding - Material No. 15

These materials were selected because there were more significant data for these than others within the same group. Data from the five sidewall panels was averaged since the panels were the same except for the coloring. The window reveal and window transparency data were averaged and treated on one material.

TABLE 4.13

INPUT DATA FOR DACFIR MODEL
VARIABLES ASSOCIATED WITH THE SMOLDERING STATE

VARIABLE	INTERIOR STRUCTURE						
	Carpet	Sidewall	Window Reveal and Transparency	Passenger Service Unit	Stowage Bin	Ceiling	Seats
Heat Flux that Induces Smoldering q_p [$Btu/(sec \cdot ft^2)$]	2.00	2.20	5.40	5.40	2.80	4.00	2.50
Time to Begin Smoldering t_p (sec)	8.00	20.00	12.00	10.00	14.00	7.00	8.00
Time to Char in the Smoldering State t_{pc} (sec)	500.00	67.00	150.00	150.00	180.00	120.00	600.00
Smoke Release Rate per Unit Area in the Smoldering State r_{ss} [$part/(sec \cdot ft^2)$]	10.00	25.00	25.00	25.00	25.00	75.00	10.00
Release Rate of HCN per Unit Area in the Smoldering State r_s (HCN)[$lb \times 10^{-6}/(sec \cdot ft^2)$]	0.32	0.05	0.0	0.0	0.05	0.0	0.62
Release Rate of HCl per Unit Area in the Smoldering State r_s (HCl)[$lb \times 10^{-6}/(sec \cdot ft^2)$]	0.70	4.00	0.10	0.20	4.00	0.74	0.84

TABLE 4.13 (Continued)

INPUT DATA FOR DACFIR MODEL
VARIABLES ASSOCIATED WITH THE SMOLDERING STATE

VARIABLE	INTERIOR STRUCTURE						
	Carpet	Sidewall	Window Reveal and Transparency	Passenger Service Unit	Stowage Bin	Ceiling	Seats
Release Rate of HF per Unit Area in the Smoldering State r_s (HF)[lb x 10^{-6}/(sec$\cdot$ft^2)]	0.0	6.00	0.0	0.0	6.00	2.00	0.0
Release Rate of CO per Unit Area in the Smoldering State r_s (CO)[lb x 10^{-6}/(sec$\cdot$ft^2)]	2.00	30.00	16.00	16.00	30.00	4.00	10.00
Release Rate of SO_2 per Unit Area in the Smoldering State r_s (SO_2)[lb x 10^{-6}/(sec$\cdot$ft^2)]	3.00	0.0	0.0	0.0	0.0	0.0	0.0
Time to Cease Smoldering When the Heat Flux is Reduced to Zero t_{pe} (sec)	10.0	13.5	1.8	1.2	2.4	6.6	2.4

The data in Tables 4.1 through 4.13 were derived by plotting the corresponding data in Appendix B and extrapolating and/or interpolating to provide data over the range of heat fluxes that might be encountered. The tables were derived with the knowledge that the DACFIR Model treats the data in the following manner.

1. If the value of a material property is required by the program at a heat flux which lies between two entries in the table, linear interpolation is used to determine the value of the material property.

2. If the value of a material property is required by the program at a heat flux below at the lowest heat flux in the table, the value of the property corresponding to the lowest heat flux entry is used.

3. If the value of a material property is required by the program at a heat flux greater than the highest heat flux in the table, linear extrapolation is used to determine the material property value.

The laboratory tests provided a valuable set of data for generating input data for the DACFIR Model; however, because the data set was incomplete, some of the values in Tables 4.1 through 4.12 are estimations rather than actual measurements. The values in the tables which are estimates are underscored with a dashed line. Plots of the data in Tables 4.1 through 4.12 are presented in Figures 4.1 through 4.12. In these plots, the estimated points are enclosed by a circle, whereas the measured points are enclosed by a square. The following notes indicate how some of the estimations were made.

1. The stowage bin material was not tested in a vertical orientation. The vertically upward and vertically downward flame spread rates (Tables 4.2 and 4.3, respectively) entered for the stowage bin are the same as those derived for the sidewalls. The sidewall and stowage bin are made of similar materials.

2. Vertical flame spread rates were not measured for the seat material. The vertically upward flame spread rates in Table 4.2 for seats are 1.5 times the horizontal

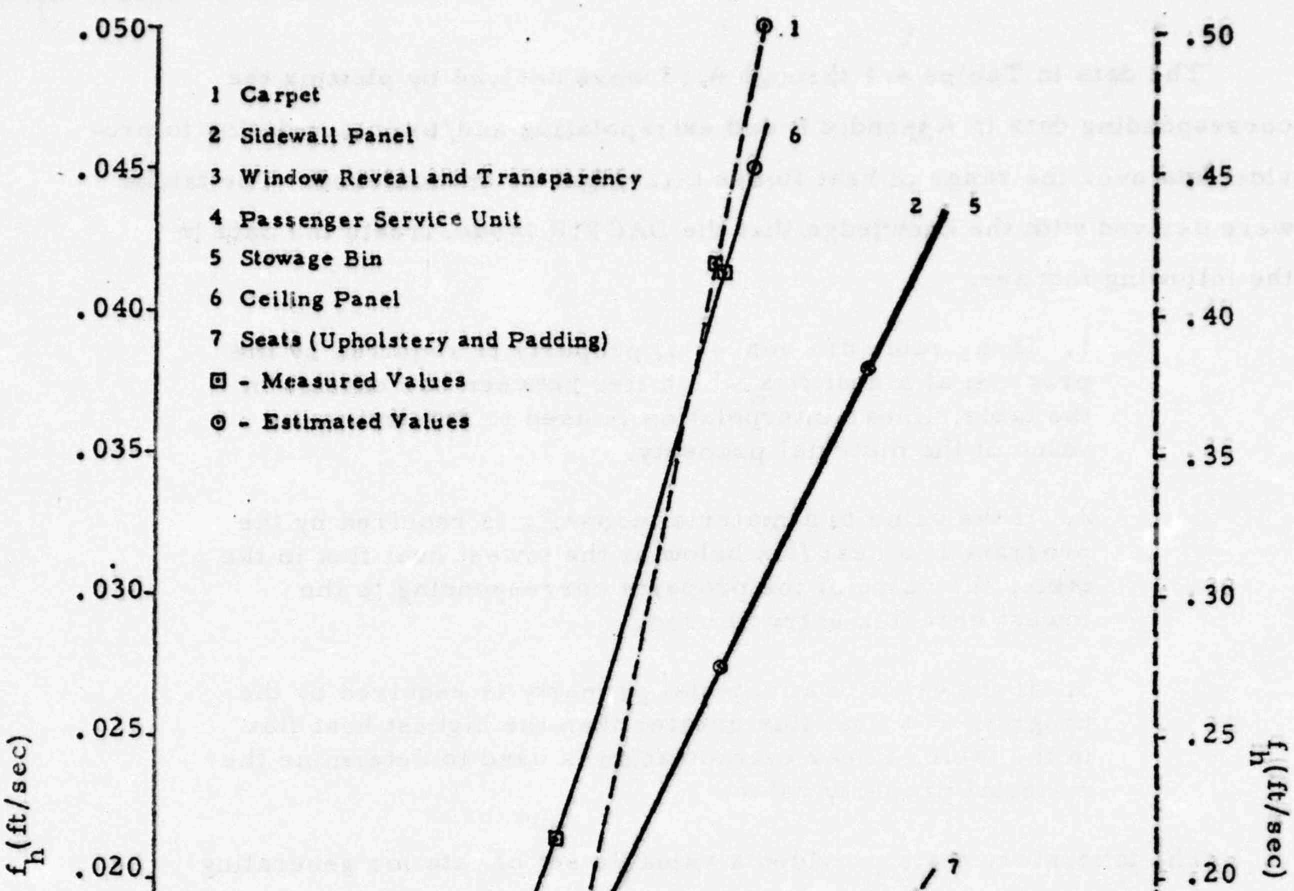


Figure 4.1 Horizontal Flame Spread Rate (f_h) Versus Heat Flux (q) (Dashed lines are based on the right-hand scale; solid lines are based on the left-hand scale)

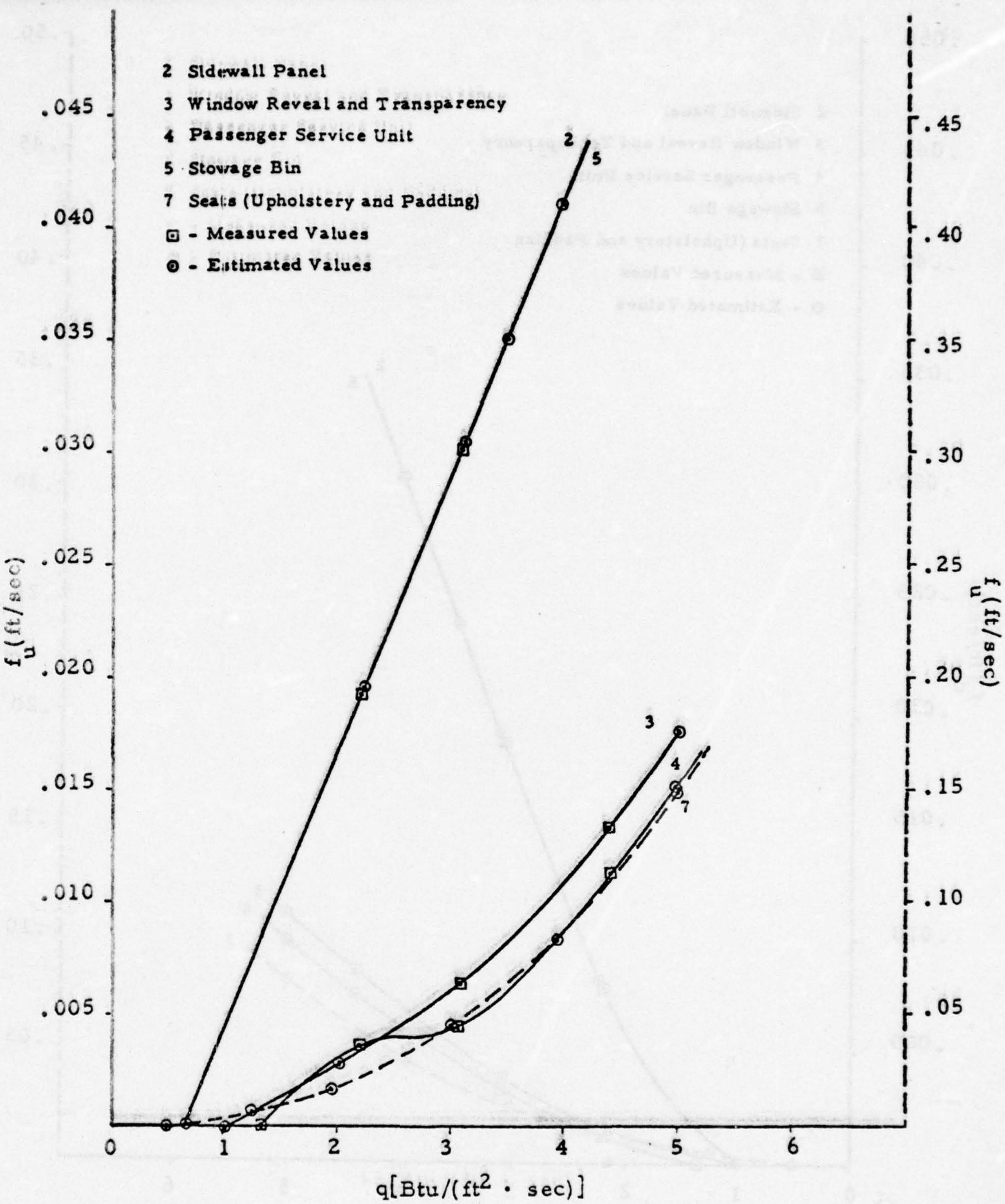


Figure 4.2 Vertically Upward Flame Spread Rate (f_u) Versus Heat Flux (q)
(Dashed lines are based on the right-hand scale; solid lines are based on the left-hand scale)

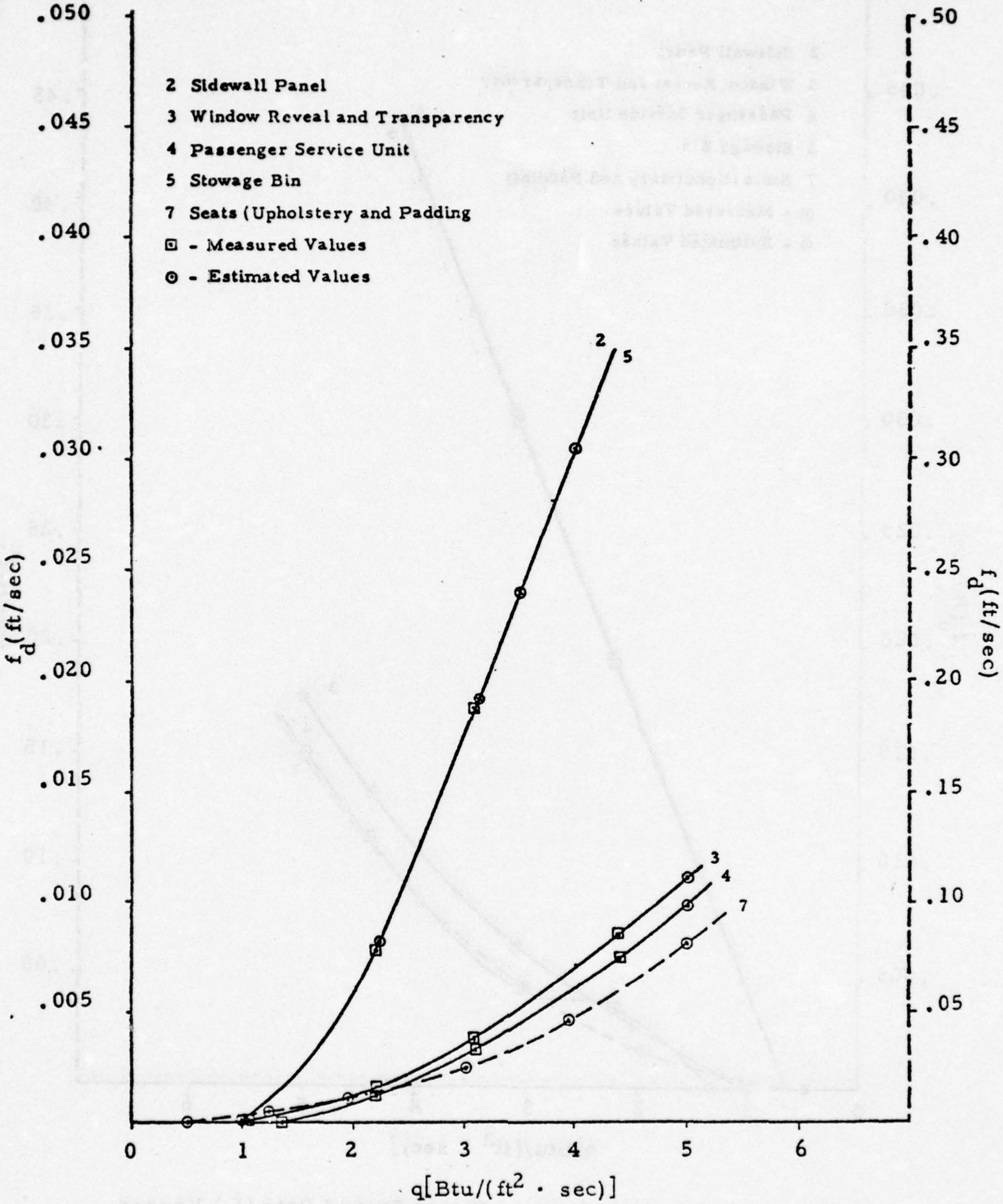


Figure 4.3 Vertically Downward Flame Spread Rate (f_d) Versus Heat Flux (q)
(Dashed lines are based on the right-hand scale; solid lines are based on the left-hand scale)

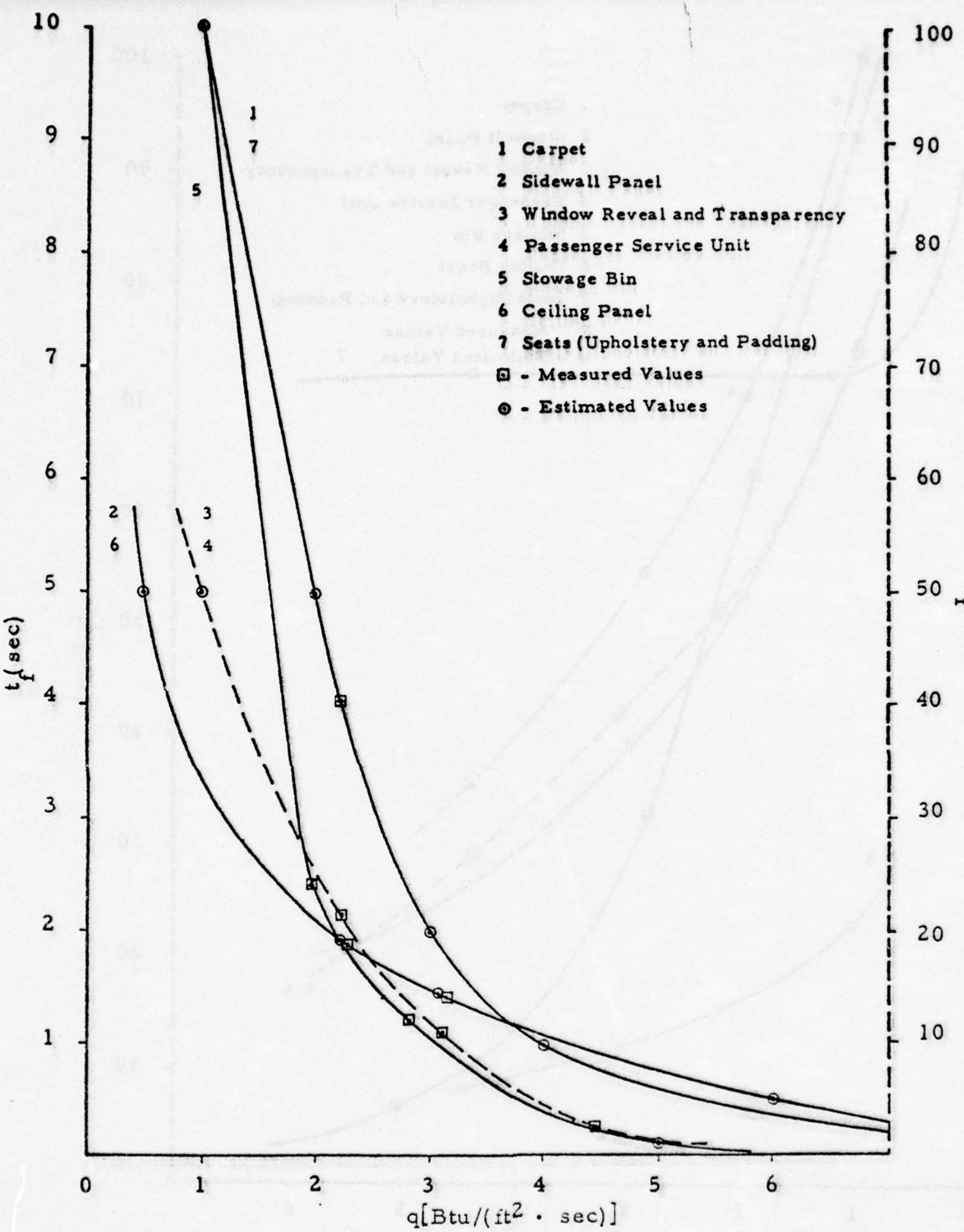


Figure 4.4 Time to Flame (t_f) Versus Heat Flux (q)
(Dashed lines are based on the right-hand scale; solid lines are based on the left-hand scale)

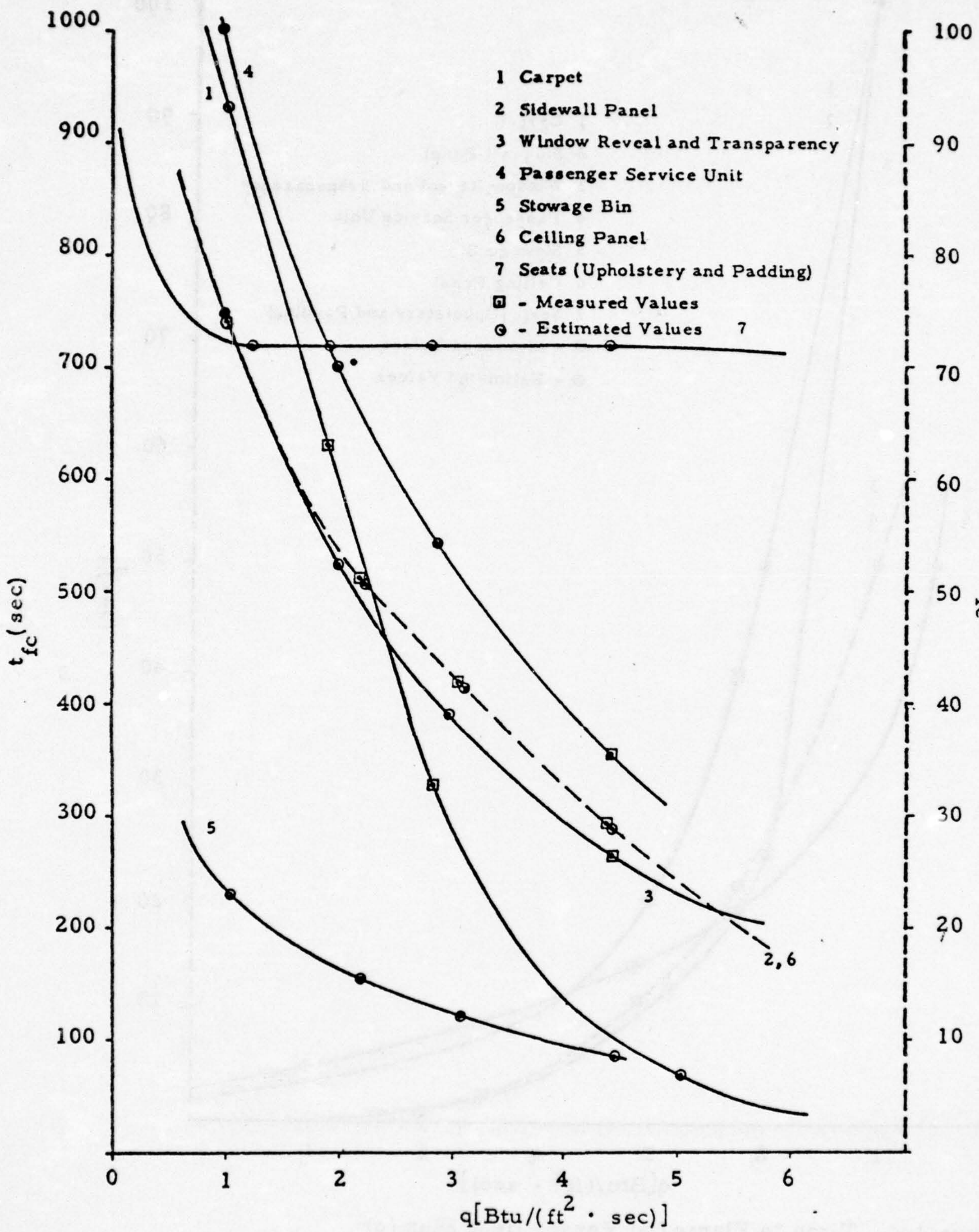


Figure 4.5 Time to Char from the Flaming State (t_{fc}) Versus Heat Flux (q)
(Dashed lines are based on the right-hand scale; solid lines are based on the left-hand scale)

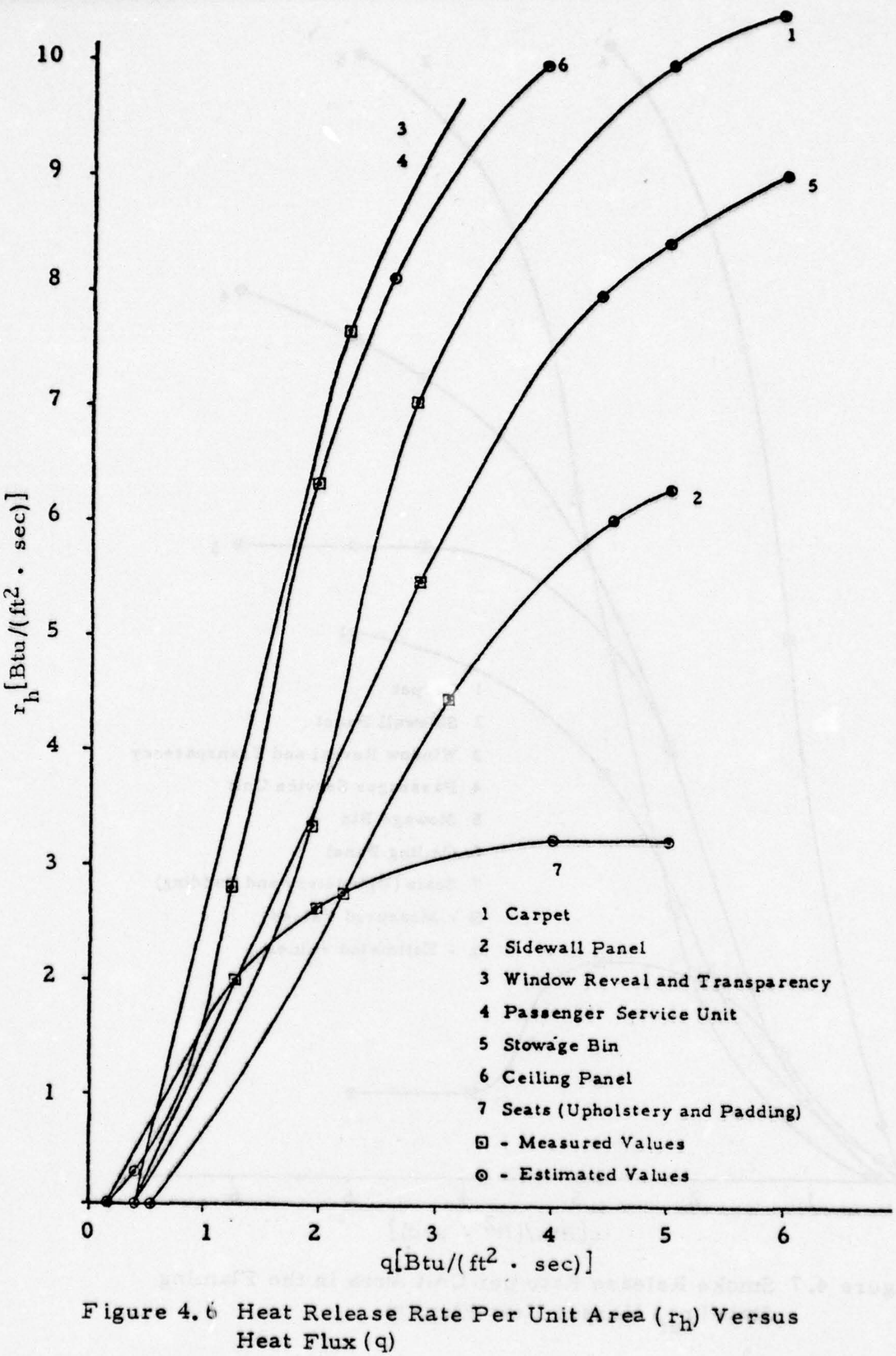


Figure 4.6 Heat Release Rate Per Unit Area (r_h) Versus Heat Flux (q)

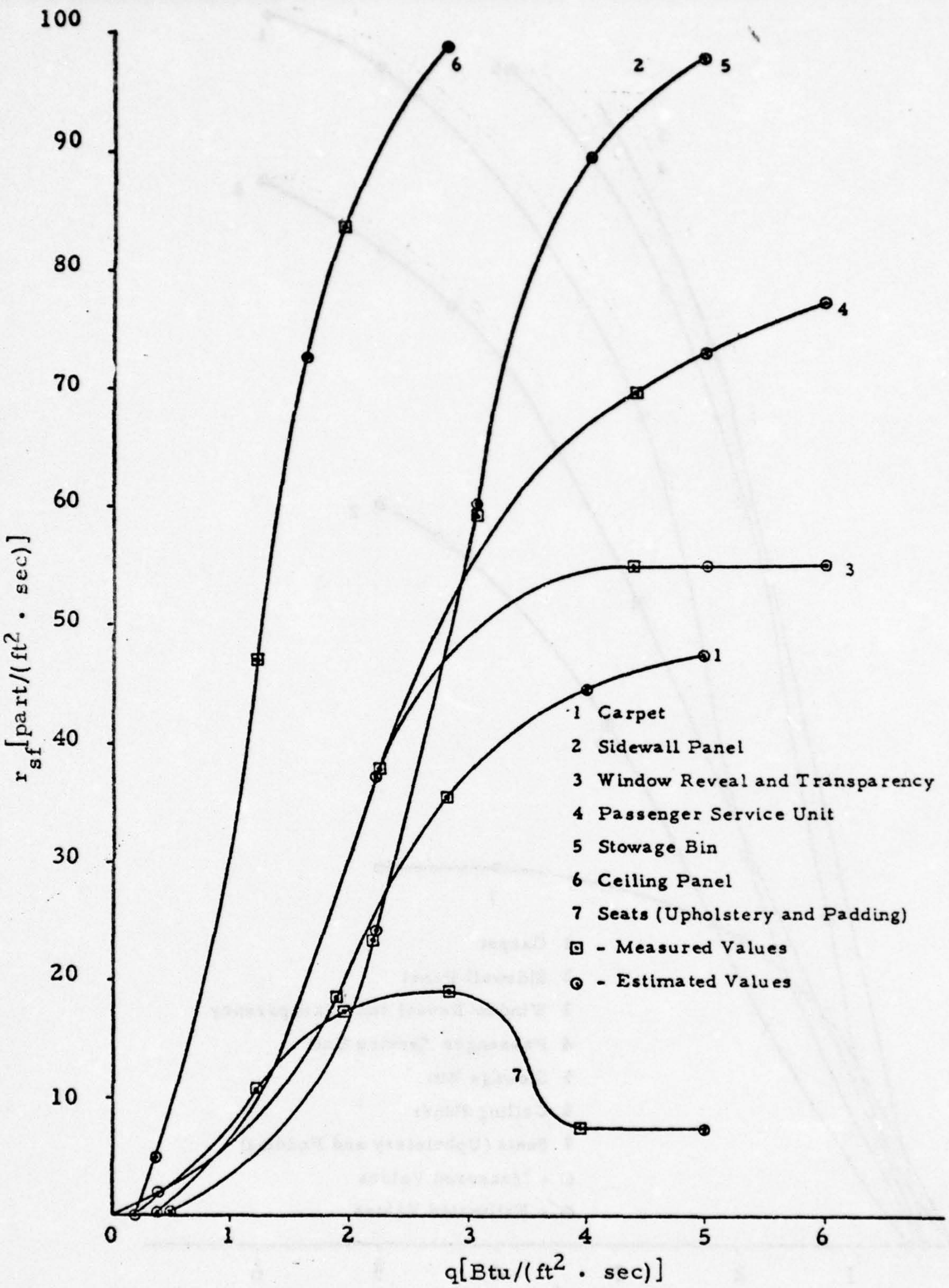


Figure 4.7 Smoke Release Rate per Unit Area in the Flaming State (r_{sf}) Versus Heat Flux (q)

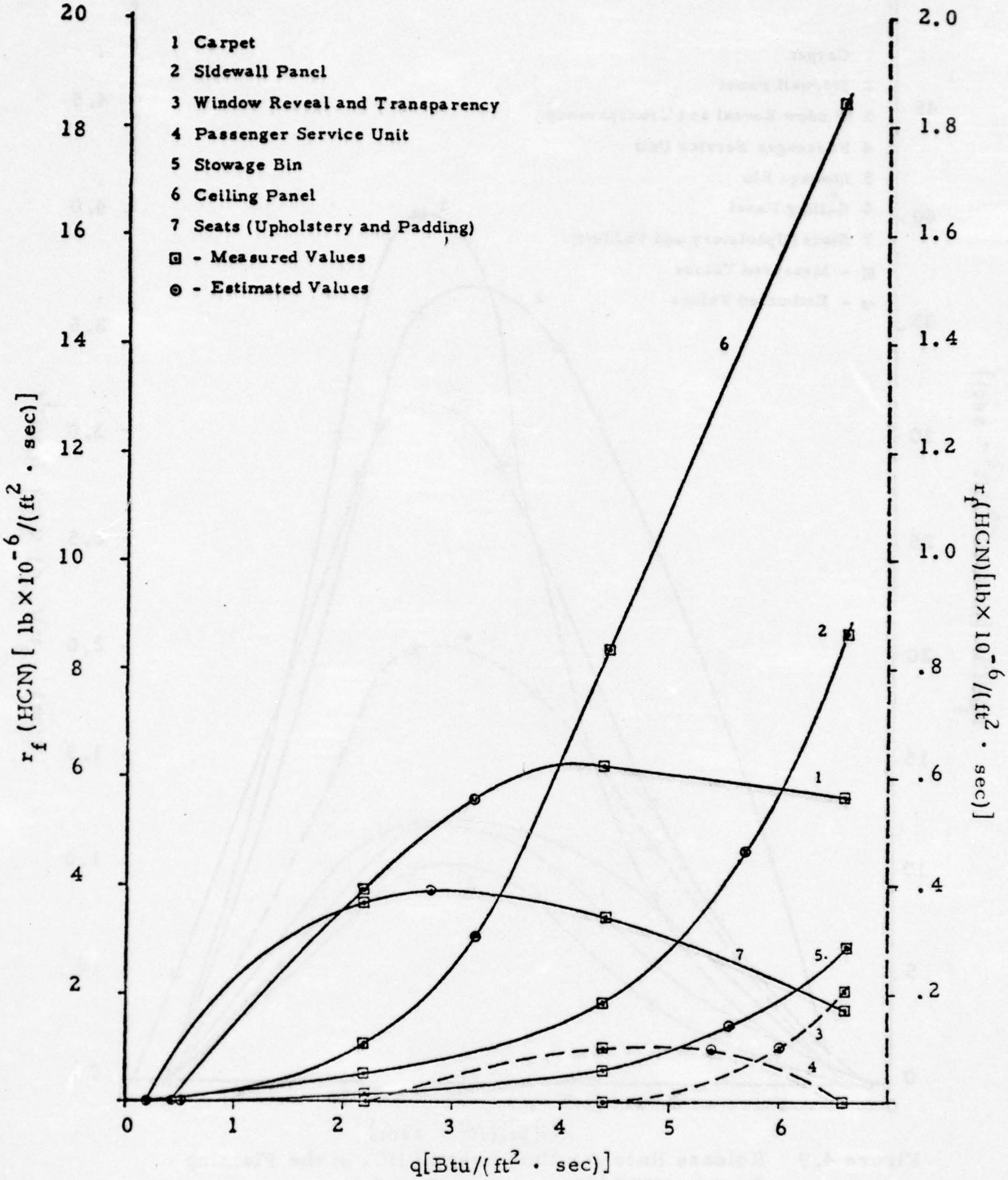


Figure 4.8 Release Rate per Unit Area of HCN in the Flaming State [r_f(HCN)] Versus Heat Flux (q) (Dashed lines are based on the right-hand scale; lines are based on the left-hand scale)

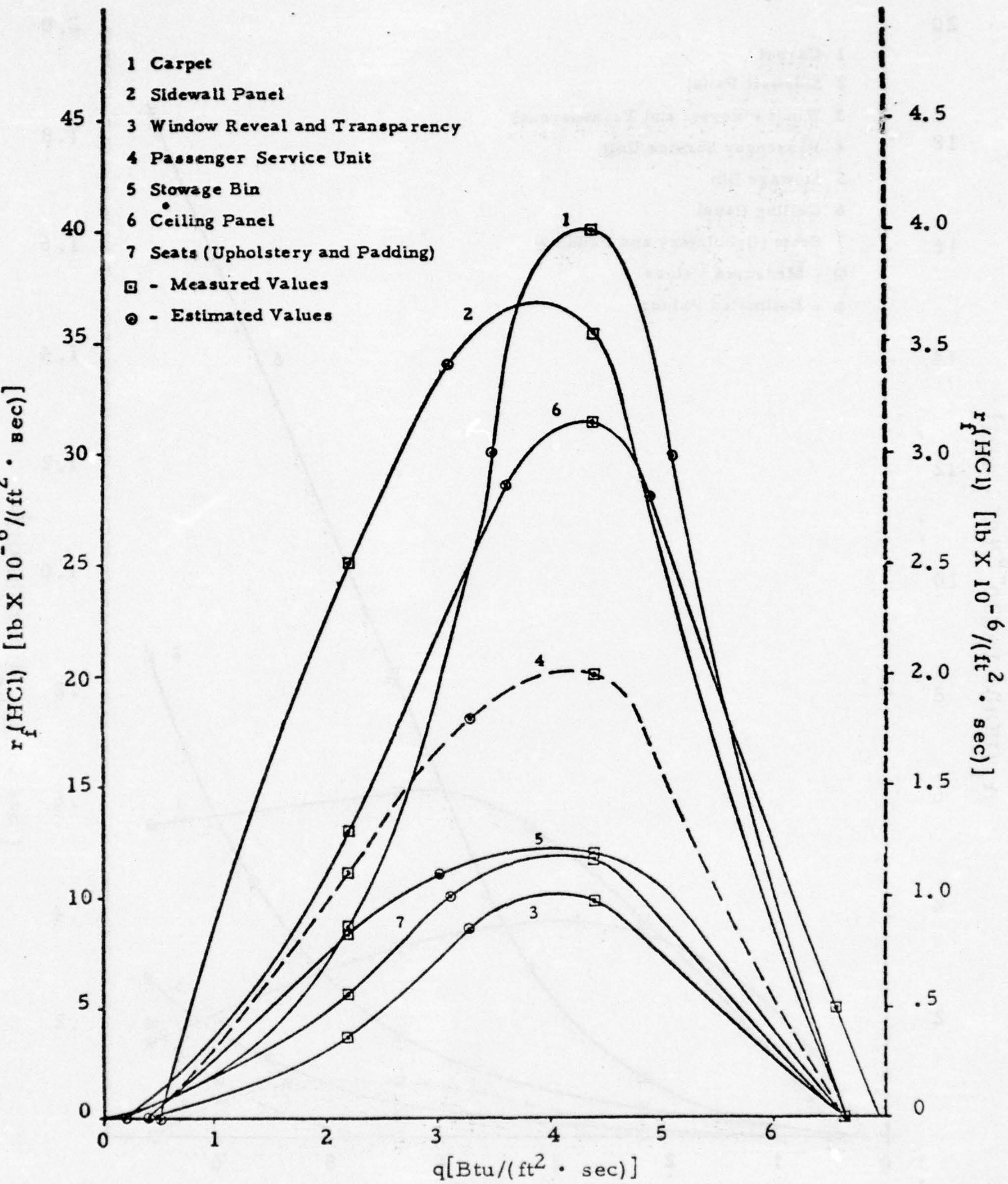


Figure 4.9 Release Rate per Unit Area of HCl in the Flaming State [r_f(HCl)] Versus Heat Flux (q)
(Dashed lines are based on the right-hand scale; solid lines are based on the left-hand scale)

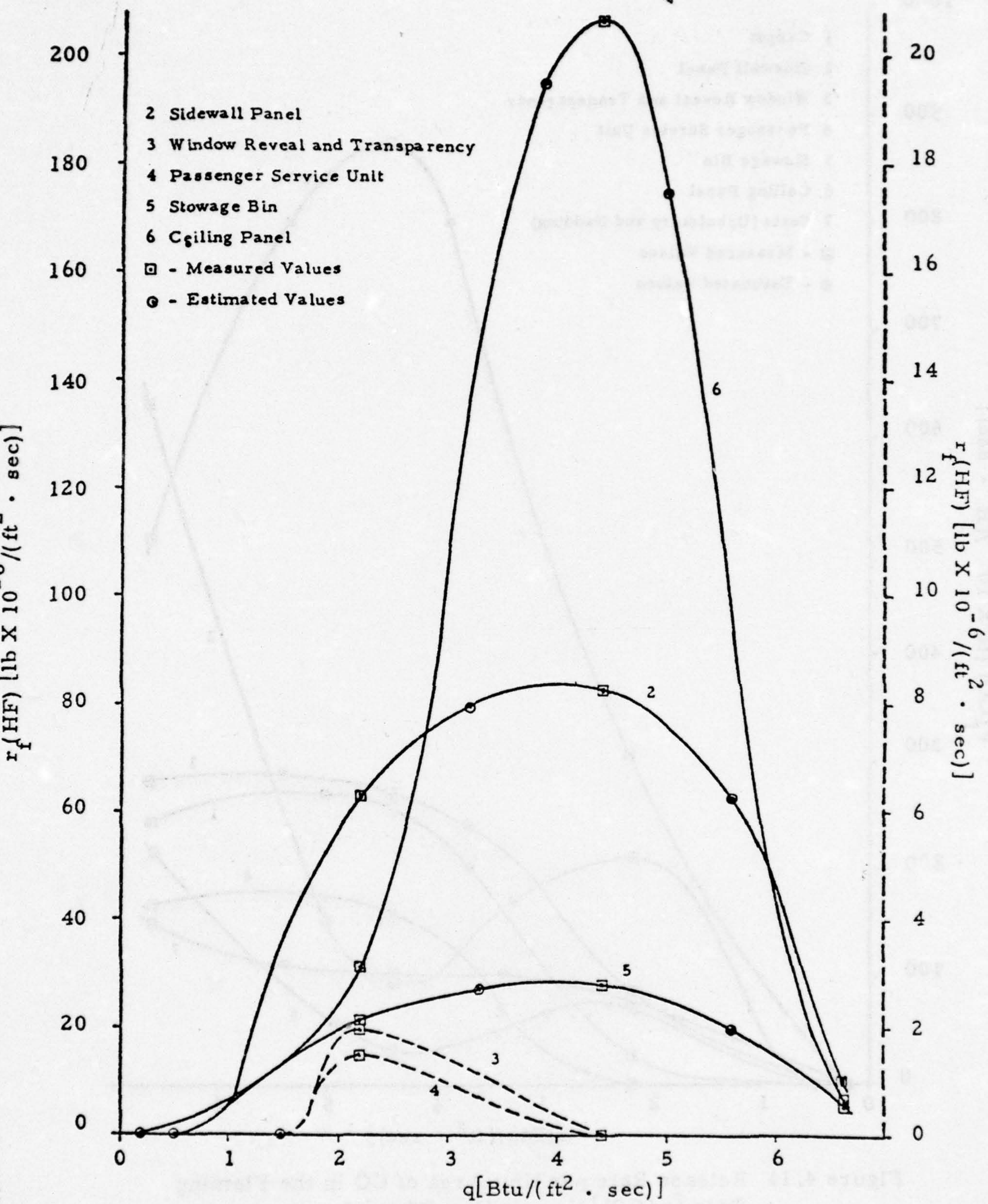


Figure 4.10 Release Rate per Unit Area of HF in the Flaming State [$r_f(HF)$] Versus Heat Flux (q) (Dashed lines are based on the right-hand scale; lines are based on the left-hand scale)

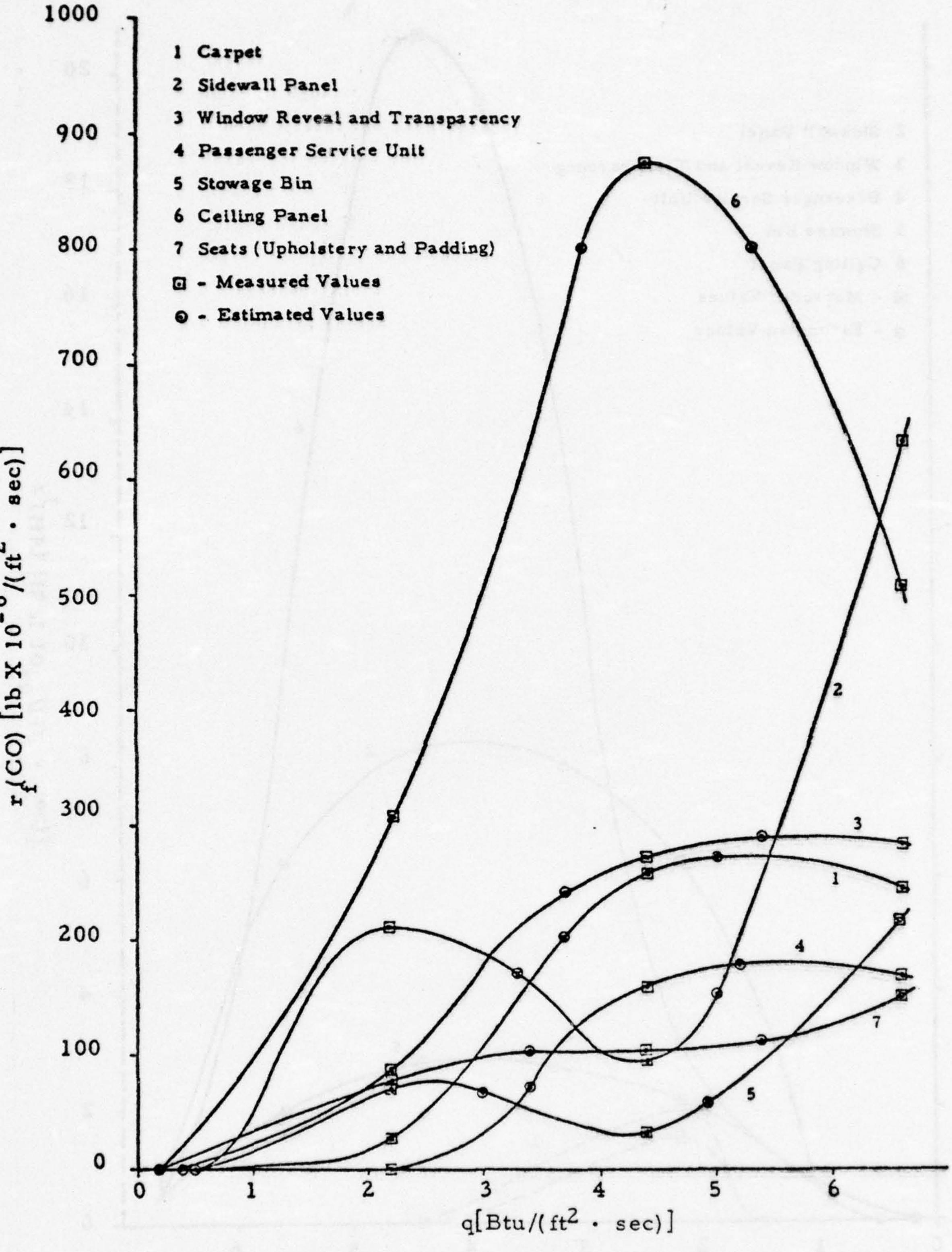


Figure 4.11 Release Rate per Unit Area of CO in the Flaming State [$r_f(CO)$] Versus Heat Flux (q)

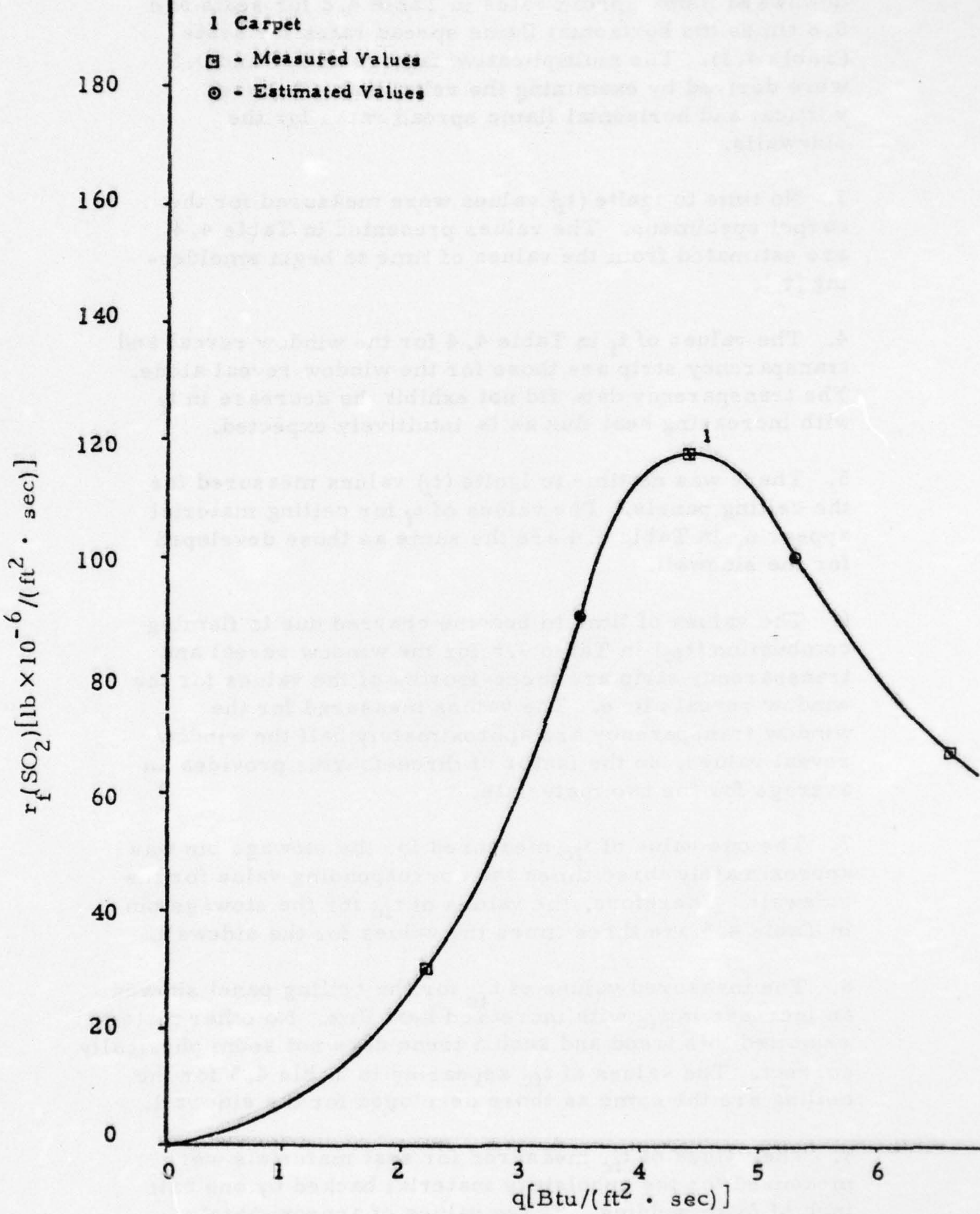


Figure 4.12 Release Rate per Unit Area of SO_2 in the Flaming State $[r_f(SO_2)]$ Versus Heat Flux (q)

flame spread rate for seats (Table 4.1). The vertically downward flame spread rates in Table 4.2 for seats are 0.8 times the horizontal flame spread rates for seats (Table 4.1). The multiplicative factors of 1.5 and 0.8 were derived by examining the relationship between vertical and horizontal flame spread rates for the sidewalls.

3. No time to ignite (t_f) values were measured for the carpet specimens. The values presented in Table 4.4 are estimated from the values of time to begin smoldering (t_p).

4. The values of t_f in Table 4.4 for the window reveal and transparency strip are those for the window reveal alone. The transparency data did not exhibit the decrease in t_f with increasing heat flux as is intuitively expected.

5. There was no time to ignite (t_f) values measured for the ceiling panels. The values of t_f for ceiling material appearing in Table 4.4 are the same as those developed for the sidewall.

6. The values of time to become charred due to flaming combustion (t_{fc}) in Table 4.5 for the window reveal and transparency strip are three-fourths of the values for the window reveal alone. The values measured for the window transparency are approximately half the window reveal values, so the factor of three-fourths provides an average for the two materials.

7. The one value of t_{fc} measured for the stowage bin was approximately three times the corresponding value for the sidewall. Therefore, the values of t_{fc} for the stowage bin in Table 4.5 are three times the values for the sidewall.

8. The measured values of t_{fc} for the ceiling panel showed an increase in t_{fc} with increased heat flux. No other material exhibited this trend and such a trend does not seem physically correct. The values of t_{fc} appearing in Table 4.5 for the ceiling are the same as those developed for the sidewall.

9. The values of t_{fc} measured for seat materials were measured for the upholstery material backed by one half inch of foam padding. Three values of approximately 180.0 seconds were measured for three different heat fluxes. The seats in the aircraft contain four inches of foam padding. As an approximation, the values of t_{fc} for seats in Table 4.5 are four times the measured values or 720.0 seconds.

10. Only one data point was reported for the heat release rate per unit area (r_h) for the window reveal/passenger service unit material. Therefore, the values in Table 4.6 for r_h for the window reveal and transparency strip are those corresponding to the window transparency. These values are also used for the passenger service unit in Table 4.6.

11. No values of smoke release rate per unit area for flaming combustion (r_{sf}) were measured for the stowage bin material. The values presented in Table 4.7 for the stowage bin are the same as those developed for the sidewall.

12. The toxic gas release rates per unit area in Tables 4.8 through 4.12 were developed by dividing the approximate maximum concentration of the gas in the NBS Smoke Chamber test for a given heat flux by the value of t_{fc} from Figure 4.5 at that heat flux. The NBS Smoke Chamber data is presented in Tables A-26 through A-28 of Appendix A.

The data in Table 4.13 was derived by examining the data in the tables in Appendix B. The heat flux at which smoldering occurs (q_p) was selected as the heat flux at which the material would begin smoldering within 20 seconds or less from the time of exposure. Other values in the table were selected based on this value of q_p. In some cases, estimations were made to complete the data set when insufficient data was available in Appendix B. The toxic gas release rates in Table 4.13 were derived by assuming that the rates in the smoldering state are approximately one tenth of the rates in the flaming state.

SECTION 5

CONCLUSIONS

The laboratory test measurements of material flammability properties provided a data base from which an input data set was obtained to demonstrate the performance of the DACFIR Model. The measurements also served to define the flammability behavior of selected aircraft interior materials as a function of applied radiation. The following conclusions are drawn from the laboratory test program.

1. Even though a thorough error analysis was not performed to determine the accuracy of the OSU Combustion Analyzer, this device appeared to yield reasonably consistent results for the various measurements that were made. This can be inferred from the data in the tables in Appendix A for repeated measurements and from the upper and lower limits and confidence limits presented in the tables in Appendix B.

2. The flame spread rates determined by visually timing the spread of flames over a part of the specimen surface vary as a function of the distance of flame travel. This can be seen by comparing the various measurements of V1 for a given specimen, the various measurements of V2, the various measurements of V3, and the various measurements of H1.

3. Even though the ceiling panels, sidewall panels, and stowage bin materials are similar in construction, the flammability properties for these materials are in some cases very different. This is particularly noticeable with the release rates per unit area as shown in Figures 4.6 through 4.12.

4. The toxic gas release rates per unit area for several materials and several gases reach a maximum between two and five Btu/($ft^2 \cdot$ sec) and then decrease for higher heat fluxes. This effect can be seen clearly in Figures 4.8 through 4.12.

5. The data reported from the laboratory test program was incomplete and, therefore, many of the values in

Tables 4.1 through 4.13 are estimates derived to complete the input data set for the DACFIR Model. In light of this, the data in these tables and in Figures 4.1 through 4.12 should not be considered to be precise and final determinations of the flammability properties of the corresponding aircraft interior materials.

The laboratory test program described in this report represents the first time to the author's knowledge that a comprehensive set of flammability and combustion toxicity properties has been measured for aircraft interior materials for the purpose of predicting the behavior of the materials in a full-scale cabin fire. While the results of this effort to characterize the material's fire danger characteristics in an overall fashion are encouraging, further work in this area is needed. Both the test methods and data analysis technique can be improved with experience. Accurate laboratory measurements of a complete set of material properties are necessary in order to adequately predict the conditions which can occur in an aircraft cabin due to fire.

APPENDIX A

LABORATORY TEST DATA

The data presented in Tables A-1 through A-28 are measurements taken from laboratory tests on the flammability properties of representative wide-body passenger aircraft interior materials. The tables contain data for eighteen materials tested in a vertical position, a horizontal position, or in both positions. The tables for horizontal specimens contain nineteen variables; the tables for vertical specimens contain thirty-one variables. The specific definition of each variable and the manner in which each was measured are presented in Section 2 of this report. Briefly, the variables are defined as follows:

V1A through V1F are various measures of the horizontal flame spread rate for a vertical specimen.

V2A through V2D are various measures of the vertically upward flame spread rate for a vertical specimen.

V3A and V3B are measures of the vertically downward flame spread rate for a vertical specimen.

V4A1 through V4B3 are smoke release parameters for a vertical specimen.

V5A1 through V5B3 are heat release parameters for a vertical specimen.

V6A and V6B are measures of the time to begin flaming for a vertical specimen.

V7A, V7B, and V7C are measures of the time to become charred due to flaming combustion for a vertical specimen.

V8 is a measure of the time to begin smoldering for a vertical specimen.

V9 is a measure of the time to become charred due to smoldering for a vertical specimen.

V10 is the time to cease smoldering after the heat flux has been removed for a vertical specimen.

H1A through H1D are various measures of the horizontal flame spread rate on a horizontal specimen.

H2A1 through H2B2 are smoke release paramters for a horizontal specimen.

H3A1 through H3B2 are heat release parameters for a horizontal specimen.

H4A and H4B are measures of the time to begin flaming for a horizontal specimen.

H5A and H5B are measures of the time to become charred due to flaming combustion for a horizontal specimen.

H6 is a measure of the time to begin smoldering for a horizontal specimen.

H7 is a measure of the time to become charred due to smoldering for a horizontal specimen.

H8 is the time to cease smoldering after the heat flux has been removed for a horizontal specimen.

An entry of "no" in the tables for variables V1A, V1B, V1C, V1D, V1E, V1F, V2A, V2B, V2C, V2D, V3A, V3B, H1A, H1B, H1C, or H1D indicates that the flames did not spread when the specimen was contacted by a pilot flame under the heat flux condition corresponding to the entry. An entry of "no" for V6B, V7A, V7B, V7C, H4A, H4B, or H5B indicates that the material did not begin flaming under the conditions defined by the variable and the heat flux corresponding to the entry. An entry of "no" for V8, V9, H6, or H7 indicates that the material did not begin smoldering under the conditions defined by the variable and the heat flux corresponding to the entry. Blanks in the tables indicate that no data was reported for the corresponding variable and heat flux.

TABLE A-1

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 1
Carpet and Pad (wool, cut and loop)
Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	1.4	4.80	8.57			6.69
	2.2	24.00	10.91			17.45
H1B (in/min)	1.4	5.33	6.15			5.74
	2.2	18.46	11.43			14.95
H1C (in/min)	1.4	6.38	7.69			7.04
	2.2	25.00	17.14			21.07
	3.2			120.00		120.00
	4.5	300.00	300.00			300.00
H1D (in/min)	1.4	10.53	13.95			12.24
	2.2	35.29	31.58			33.44
	3.2			100.00		100.00
	4.5	300.00	300.00			300.00
H2A1 [$Btu/(ft^2 \cdot min)$]	1.4	378.1	398.1			388.1
	2.3	545.5	548.1			546.8
	3.2	691.1	660.1	677.4		676.2
	4.5	659.6				659.6

TABLE A-1 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 1

Carpet and Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [$Btu/(ft^2 \cdot min)$]	3.2	106.1	142.1			124.1
	4.5	561.4				561.4
	5.3	603.6				603.6
H2B1 (Btu/ft^2)	1.4	1663.9	1641.0			1652.5
	2.3	2134.1	2071.2			2102.7
	3.2	2231.1	2374.2	2316.6		2307.3
	4.5	1789.3				1789.3
H2B2 (Btu/ft^2)	3.2	130.4	229.8			180.1
	4.5	1942.5				1942.5
	5.3	1643.6				1643.6
H3A1 (dimensionless)	1.4	391.7	373.7			382.7
	2.3	521.7	529.3			525.5
	3.2	510.3	549.5	539.3		533.0
	4.5	512.4				512.4
H3A2 (dimensionless)	3.2	593.1	440.9			517.0
	4.5	510.2				510.2
	5.3	465.0				465.0

TABLE A-1 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 1
Carpet and Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	1.4 2.3 4.5	117.9 235.4 440.7	138.6 249.3			128.3 242.4 440.7
H3B2 (min^{-1})	3.2 4.5 5.3	313.0 297.8 364.3	325.6	289.7		309.4 297.8 364.3
H4A (min)						
H4B (min)	1.4 2.3 3.2 4.7	 9.60 0.17	 9.35			no no 9.48 0.17
H5A (min)	1.4 2.3 3.2	>10 10.53 5.43				>10 10.53 5.43

TABLE A-1 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 1
Carpet and Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)	1.4	no				no
	2.3	no				no
	3.2	3.38				3.38
H6 (min)	1.4	0.50	0.46			0.48
	2.3	0.15				0.15
	3.2	0.06	0.06			0.06
	4.5	0.04				0.04
	5.3	0.02				0.02
H7 (min)	1.4	>10				>10
	2.2	9.10				9.10
	3.2					no
H8 (min)						

TABLE A-2

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 2
Carpet and Pad (wool, loop pile)
Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	1.4	5.00	3.43			4.21
	2.2	6.32	30.00			18.16
H1B (in/min)	1.4	3.16	2.93			3.04
	2.2	6.49	9.60			8.04
H1C (in/min)	1.4	3.70	4.11			3.91
	2.2	8.82	11.11			9.97
	3.2	60.00	42.86	42.86		48.57
H1D (in/min)	1.4	5.61	6.12			5.86
	2.2	15.79	15.79			15.79
	3.2	66.67	100.00	75.00		80.56
	4.5			120.00		120.00
H2A1 [$Btu/(ft^2 \cdot min)$]	1.4	517.2	553.3			535.3
	3.2	885.6				885.6
	4.5	851.1	752.1	1039.1		880.8

TABLE A-2 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 2
Carpet and Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [Btu/(ft^2 · min)]	3.2	764.6	623.9			694.3
	5.3	694.8	710.8			702.8
H2B1 (Btu/ft^2)	1.4	878.0	916.6			897.3
	3.2	1374.1				1374.1
	4.5	1710.0	1069.0	1120.7		1299.9
H2B2 (Btu/ft^2)	2.3	660.5				660.5
	3.2	816.5	797.2			806.9
	5.3	1506.7	1498.7			1502.7
H3A1 (dimensionless)	1.4	196.9	198.9			197.9
	3.2	340.1				340.1
	4.5	331.9	422.0	353.1		369.0
H3A2 (dimensionless)	2.3	351.6				351.6
	3.2	352.0	362.8			357.4
	5.3	327.0	357.5			342.3

TABLE A-2 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 2

Carpet and Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	1.4	223.7	229.7			226.7
	3.2	527.9				527.9
	4.5	624.3	665.9	1033.2		774.5
H3B2 (min^{-1})	2.3	111.0				111.0
	3.2	429.2	472.2			450.7
	5.3	447.0	584.3			515.7
H4A (min)						
H4B (min)	1.4					no
	2.3					no
	3.2	1.66	1.99			1.83
	4.5	0.24	0.16			0.20
	5.3	0.06	0.04			0.05
H5A (min)	1.4	> 10	> 10			> 10
	2.3	9.13	8.56			8.84
	3.2	6.28	4.17	3.59		4.68

TABLE A-2 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 2
Carpet and Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)	1.4					no
	2.3					no
	3.2	6.84	5.61			6.23
	4.5	3.37	2.58			2.97
H6 (min)	1.4	0.32				0.32
	2.3	0.15				0.15
	3.2	0.08	0.09			0.09
	4.5	0.06	0.08			0.07
	5.3	0.01	0.03			0.02
H7 (min)	1.4	>10				>10
	2.2	10.60				10.60
	3.2	>10				>10
H8 (min)						

TABLE A-3

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 3

Sidewall Panel (white background, printed letters)

Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Averag
V1A (in/min)	1.5					no
	2.5	12.00	17.14	8.00		12.3
	3.5	4.62	6.67	10.91		7.4
V1B (in/min)	1.5					no
	2.5	10.43	10.43	4.07		8.3
	3.5	7.27	10.00	8.57		8.6
V1C (in/min)	1.5					no
	2.5	8.00	6.92	5.81		6.9
	3.5	9.47	9.73	12.86		10.6
V1D (in/min)	1.5					no
	2.5	15.00	9.23	13.33		12.5
	3.5	10.91	15.00	24.00		16.6
V1E (in/min)	1.5					no
	2.5	10.91	10.00	12.63		11.1
	3.5		14.12	16.00		15.0

TABLE A-3 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 3
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)	1.5					no
	2.5	6.00	5.81	5.00		5.60
	3.5	13.33	9.73			11.53
V2A (in/min)	1.5	120.00	18.95			69.47
	2.5	21.18	13.85	12.41		15.81
	3.5	21.18	22.50	20.00		21.23
V2B (in/min)	2.5	15.00	25.71	13.58		18.10
	3.5	19.46	17.56	23.71		20.91
V2C (in/min)	2.5		25.71	36.00		30.86
	3.5	12.86	16.36	36.00		21.74
V2D (in/min)	2.5	36.00	36.00	30.00		34.00
	3.5	22.50	30.00	45.00		32.50

TABLE A-3 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 3
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)	2.5 3.5	12.86 5.81	10.00 7.83	2.61 5.45		8.49 6.36
V3B (in/min)	2.5 3.5	4.19 10.59	5.29 15.00	4.74 10.91		4.74 12.17
V4A1 [$Btu/(ft^2 \cdot min)$]	2.5 3.5	303.7 440.7	320.7 441.2	334.6		319.7 441.0
V4A2 [$Btu/(ft^2 \cdot min)$]	2.5 3.5 5.0	268.5 431.1 558.8	275.2	283.3		275.7 431.1 558.8
V4A3 [$Btu/(ft^2 \cdot min)$]	2.5 5.0	73.8 558.8	95.4	95.5		88.2 558.8

TABLE A-3 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 3
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)	2.5 3.5	116.1 238.0	132.0 180.3	149.1		132.4 209.2
V4B2 (Btu/ft^2)	2.5 3.5 5.0	122.9 163.3 437.5	139.9	139.3		134.0 163.3 437.5
V4B3 (Btu/ft^2)	2.5 5.0	98.6 437.5	122.7	116.8		112.7 437.5
V5A1 (dimensionless)	2.5 3.5	51.9 87.2	47.5 92.0	43.5		47.7 89.6
V5A2 (dimensionless)	2.5 3.5 5.0	62.3 92.7 188.6	55.8	50.5		56.2 92.7 188.6

TABLE A-3 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 3
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	2.5 6.0	24.1 234.2	21.8	23.2		23.0 234.2
V5B1 (min^{-1})	2.5 3.5	350.3 468.6	184.6 595.0	152.5		229.1 531.8
V5B2 (min^{-1})	2.5 3.5 5.0	209.5 655.1 1090.4	174.9	175.7		186.7 655.1 1090.4
V5B3 (min^{-1})	2.5 6.0	73.2 2577.3	53.7	60.8		62.7 2577.3
V6A (min)	1.5 2.5 3.5	.02 .04 .03	.04 .03 .02	 .03 .02		.03 .03 .02

TABLE A-3 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 3
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	1.5					no
	2.5					no
	3.5					no
	5.0	.21	.22	.18		.20
V7A (min)	1.5					no
	2.5	1.01	.91	.90		.94
	3.5	1.02	.99	1.19		1.07
V7B (min)	1.5					no
	2.5	1.01	.91	.90		.94
	3.5	.62	.50	.58		.57
V7C (min)	1.5					no
	2.5					no
	3.5					no
	5.0	.68	.32	.32		.44
V8 (min)	2.5	.32	.29	.28		.30

TABLE A-3 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 3
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)	2.5	.98	1.17	.98		1.04
V10 (min)		.19	.26	.18	.22	.21

TABLE A-4

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 4
Sidewall Panel (yellow with geometric figure)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1A (in/min)	1.5					no
	2.5	13.33	13.33	10.00		12.22
	3.5	8.57	5.71	6.67		6.98
V1B (in/min)	1.5					no
	2.5	6.32	8.57	9.23		8.04
	3.5		8.00			8.00
V1C (in/min)	1.5					no
	2.5	7.50	6.92	8.00		7.47
	3.5	12.86	9.47	12.41		11.58
V1D (in/min)	1.5					no
	2.5	12.00	12.00			12.00
	3.5	9.23	15.00	12.00		12.08
V1E (in/min)	1.5					no
	2.5	6.32	8.28	10.00		8.20
	3.5	14.12	13.33	12.00		13.15

TABLE A-4 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 4

Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)	1.5					no
	2.5	6.79	6.55	6.79		6.71
	3.5	16.36	15.65	12.86		14.96
V2A (in/min)	2.5	22.50	14.40	12.86		16.59
	3.5	17.14	21.18	16.36		18.23
V2B (in/min)	2.5	16.74	14.40	24.00		18.38
	3.5	25.71	18.95	21.82		22.16
V2C (in/min)	2.5	15.00	13.85	18.00		15.62
	3.5	22.50	18.00	25.71		22.07
V2D (in/min)	2.5	20.00	18.00	18.95		18.98
	3.5	24.00	27.69	27.69		26.46

TABLE A-4 (Continued)
LABORATORY TEST MEASUREMENTS - MATERIAL NO. 4
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)	2.5	3.27		3.67		3.47
V3B (in/min)	2.5 3.5	6.32 14.40	7.06 14.40	6.43 15.65		6.60 14.82
V4A1 [Btu/(ft^2 . min)]						
V4A2 [Btu/(ft^2 . min)]						
V4A3 [Btu/(ft^2 . min)]						

TABLE A-4 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 4

Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)						
V4B3 (Btu/ft^2)						
V5A1 (dimensionless)						
V5A2 (dimensionless)						

TABLE A-4 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 4
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)						
V5B1 (min^{-1})						
V5B2 (min^{-1})						
V5B3 (min^{-1})						
V6A (min)	2.5 3.5	.02 .03	.02 .02	.02 .02		.02 .02

TABLE A-4 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 4
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	1.5 2.5 3.5					no no no
V7A (min)	1.5 2.5 3.5	 .76 .48	 .77 .52	 .77 .49		no .76 .50
V7B (min)	1.5 2.5 3.5	 .88 1.37	 .80 .61	 .74 .58		no .81 .85
V7C (min)	1.5 2.5 3.5					no no no
V8 (min)	2.5	.22	.21	.23		.22

TABLE A-4 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 4
Sidewall Panel

Data Type	Heat Flux (W/cm²)	Individual Values 1	2	3	4	Average
V9 (min)	2.5	1.12	1.01	.98		1.04
V10 (min)						

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DAYTON AIRCRAFT CABIN FIRE MODEL. VOLUME II. LABORATORY TEST PR--ETC(U)

JUN 76 J B REEVES DOT-FA74WA-3532

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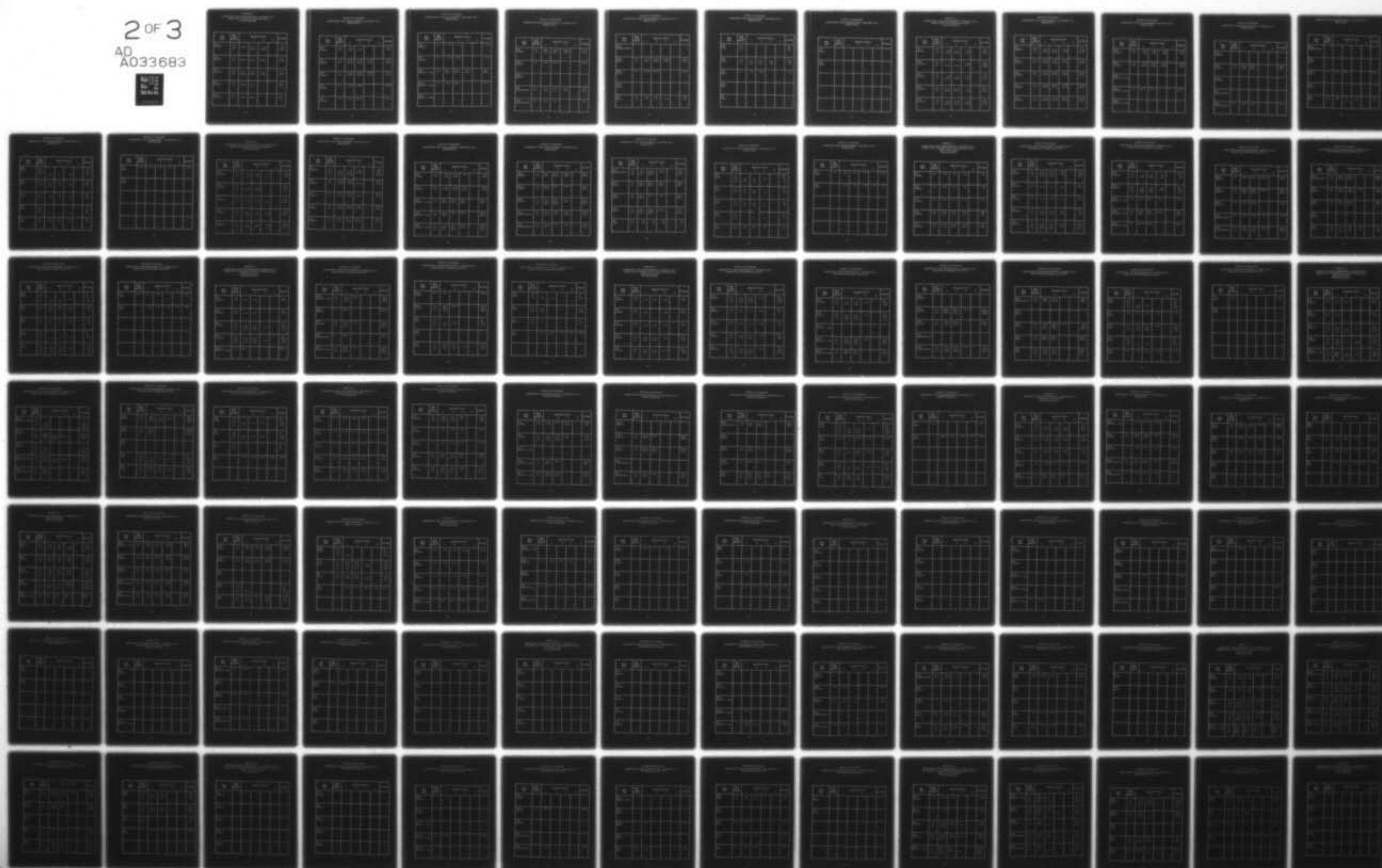

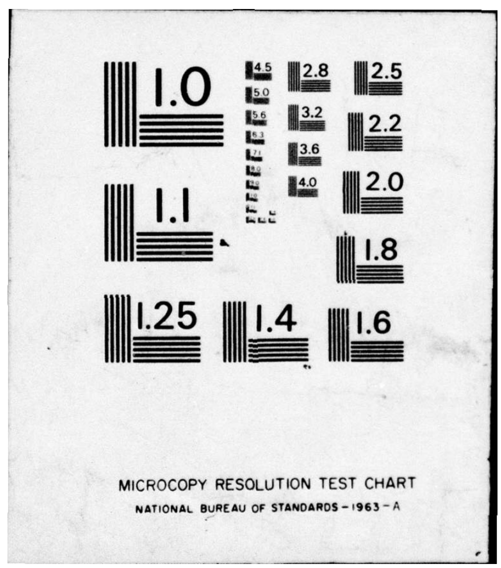
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MICROCOPY RESOLUTION TEST CHART
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TABLE A-5

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 5
Sidewall Panel (orange with geometric figure)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1A (in/min)	1.5					no
	2.5	3.64	2.61	3.16		3.13
	3.5		17.14	15.00		16.07
V1B (in/min)	1.5					no
	3.5	10.91	13.33	12.00		12.08
V1C (in/min)	1.5					no
	2.5	6.32	6.10	6.10		6.17
	3.5	12.86	12.86	13.85		13.19
V1D (in/min)	1.5					no
	2.5	30.00	8.57			19.29
V1E (in/min)	1.5					no
	2.5	7.50	8.89			8.19

TABLE A-5 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 5
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)	1.5 2.5	no 6.79	6.55			no 6.67
V2A (in/min)	2.5 3.5	10.00 21.18	11.61 30.00	11.25 27.69		10.95 26.29
V2B (in/min)	2.5 3.5	10.75 36.00	10.91 34.29	15.00 32.73		12.22 34.34
V2C (in/min)	2.5	13.85	10.00			11.92
V2D (in/min)	2.5	13.33	20.00			16.67

TABLE A-5 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 5
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)	2.5	3.10	3.53			3.32
V3B (in/min)	2.5	5.63	5.81			5.72
V4A1 [Btu/(ft^2 · min)]	2.5 3.5	351.6 398.7	317.4 397.7	338.7 391.8		335.9 396.1
V4A2 [Btu/(ft^2 · min)]	2.5	326.5	352.2			339.4
V4A3 [Btu/(ft^2 · min)]						

TABLE A-5 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 5
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)	2.5 3.5	160.2 180.4	143.0 188.4	144.0 164.3		149.1 177.7
V4B2 (Btu/ft^2)	2.5	150.9	170.0			160.5
V4B3 (Btu/ft^2)						
V5A1 (dimensionless)	2.5 3.5	75.2 99.3	59.6 97.3	58.4 87.3		64.4 94.6
V5A2 (dimensionless)	2.5	54.2	61.6			57.9

TABLE A-5 (Continued)
LABORATORY TEST MEASUREMENTS - MATERIAL NO. 5
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)						
V5B1 (min^{-1})	2.5 3.5	311.8 732.7	317.4 604.2	262.1 615.9		297.1 650.9
V5B2 (min^{-1})	2.5	174.2	179.2			176.7
V5B3 (min^{-1})						
V6A (min)	2.5 3.5	.04 .04	.04 .03	 .04		.04 .04

TABLE A-5 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 5
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	1.5 2.5 3.5					no no no
V7A (min)	1.5 2.5 3.5	 1.31 1.04	 1.08 1.33	 1.09 .48		no 1.16 .95
V7B (min)	2.5	.90	.84			.87
V7C (min)						
V8 (min)						

TABLE A-5 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 5
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)						
V10 (min)						

TABLE A-6

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 6
Sidewall Panel (blue with geometric figure)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1A (in/min)	1.5					no
	2.5	4.80	5.71	4.00		4.84
	3.5	12.00	24.00	13.33		16.44
V1B (in/min)	1.5					no
	2.5			4.80		4.80
	3.5	18.46	24.00	13.33		18.60
V1C (in/min)	1.5					no
	2.5	7.20	7.06	5.29		6.52
	3.5	18.00	16.36	16.36		16.91
V1D (in/min)	1.5					no
	2.5	30.00	20.00	5.71		18.57
	3.5	20.00	24.00	9.23		17.74
V1E (in/min)	1.5					no
	2.5	5.58	12.00	6.00		7.86
	3.5	20.00	12.63	16.00		16.21

TABLE A-6 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 6

Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)	1.5					no
	2.5	6.55	11.61	6.79		8.32
	3.5	16.36	15.00	13.33		14.90
V2A (in/min)	2.5	11.25	7.00	10.91		9.72
	3.5	24.00	27.69	25.71		25.80
V2B (in/min)	2.5	16.36	12.00	12.41		13.59
	3.5	42.35	48.00	45.00		45.12
V2C (in/min)	2.5	20.00	18.00	12.86		16.95
	3.5	22.50	22.50	25.71		23.57
V2D (in/min)	2.5	21.18	22.50	20.00		21.23
	3.5	20.00	21.18	32.73		24.63

TABLE A-6 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 6

Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)	2.5 3.5	3.67 7.83	3.67 7.20	3.67 7.20		3.67 7.41
V3B (in/min)	2.5 3.5	5.81 15.65	6.43 13.85	6.32 13.85		6.18 14.45
V4A1 [Btu/(ft^2 . min)]						
V4A2 [Btu/(ft^2 . min)]	3.5	336.7	317.4			327.1
V4A3 [Btu/(ft^2 . min)]						

TABLE A-6 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 6
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)	2.5 3.5	145.0 144.0	144.1 144.1			144.6 144.1
V4B3 (Btu/ft^2)						
V5A1 (dimensionless)						
V5A2 (dimensionless)	2.5	58.4	60.1			59.3

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 6
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)						
V5B1 (min^{-1})						
V5B2 (min^{-1})	2.5	262.1	269.9			266.0
V5B3 (min^{-1})						
V6A (min)	2.5 3.5	.04 .03	.03 .03	.05 .03		.04 .03

TABLE A-6 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 6

Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	1.5					no
	2.5					no
	3.5					no
	5.0	.29	.27	.28		.28
V7A (min)	1.5					no
	2.5	1.70	.88	.77		1.11
	3.5	.78	.66	.72		.72
V7B (min)	1.5					no
	2.5	.85	.78	.76		.80
	3.5	.54	.58	.67		.59
V7C (min)	1.5					no
	2.5					no
	3.5					no
	5.0	.63	.57	.28		.49
V8 (min)	2.5	.58	.30	.29		.39
	5.0	.09	.08	.09		.09

TABLE A-6 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 6

Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)	2.5	.52	1.47	1.70		1.23
V10 (min)						

TABLE A-7

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 7
Sidewall Panel (brown with wood grain pattern)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1A (in/min)	1.5					no
	2.5	9.23	8.00			8.62
	3.5	5.22	6.67	8.00		6.63
V1B (in/min)	1.5					no
	2.5	9.23	2.03			5.63
	3.5	10.43	8.28			9.36
V1C (in/min)	1.5					no
	2.5	7.06	5.81			6.43
	3.5	11.25	12.41	14.40		12.69
V1D (in/min)	1.5					no
	2.5	24.00	7.50	5.71		12.40
	3.5	12.00	10.00	10.91		10.97
V1E (in/min)	1.5					no
	2.5	5.85	6.86	7.74		6.82
	3.5	11.43	13.33	9.23		11.33

TABLE A-7 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 7
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)	1.5					no
	2.5	6.32	7.06	7.06		6.81
	3.5	13.33	12.41	12.00		12.58
	5.0	90.00	90.00			90.00
V2A (in/min)	2.5	18.95	12.00			15.47
	3.5	15.65	15.65	18.00		16.43
V2B (in/min)	2.5	20.57	12.86			16.71
	3.5	22.50	24.83	26.67		24.66
V2C (in/min)	2.5	22.50	25.71	15.00		21.07
	3.5	25.71	30.00	22.50		26.07
V2D (in/min)	2.5	13.33	32.73	25.71		23.92
	3.5	25.71	24.00	22.50		24.07

TABLE A-7 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 7
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)	2.5 3.5	2.86 6.43	2.95 6.00	3.05		2.95 6.21
V3B (in/min)	2.5 3.5	5.63 12.41	4.74 11.61	3.96 12.86		4.77 12.29
V4A1 [Btu/(ft^2 . min)]	2.5 3.5	299.0 442.5	341.0 483.4	308.0 390.2		316.0 438.7
V4A2 [Btu/(ft^2 . min)]	2.5 5.0	260.4 485.2	246.2	256.2		254.3 485.2
V4A3 [Btu/(ft^2 . min)]	2.5 5.0 6.0	72.5 404.5 574.3	70.9 390.6 694.9	72.4 418.6		71.9 404.6 634.6

TABLE A-7 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 7
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)	2.5 3.5	127.7 182.7	144.7 192.5	164.2 162.9		145.5 179.4
V4B2 (Btu/ft^2)	2.5 5.0	120.2 420.3	138.7	134.5		131.1 420.3
V4B3 (Btu/ft^2)	2.5 5.0 6.0	82.2 240.2 423.0	123.1 166.2 108.4	86.1 151.4		97.1 185.9 265.7
V5A1 (dimensionless)	2.5 3.5	57.3 124.8	54.3 97.1	52.3 110.0		54.6 110.6
V5A2 (dimensionless)	2.5 5.0	49.3 175.6	47.5	42.1		46.3 175.6

TABLE A-7 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 7
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	2.5 5.0 6.0	38.2 99.3 110.3	30.4 49.02 102.7	35.8 62.1		34.8 70.1 106.5
V5B1 (min^{-1})	2.5 3.5	242.0 442.5	300.3 483.4	186.5 390.2		242.9 438.7
V5B2 (min^{-1})	2.5 5.0	224.0 1084.6	167.4	152.5		181.3 1084.6
V5B3 (min^{-1})	2.5 5.0 6.0	181.1 866.9 877.0	155.6 648.5 1084.9	157.4 806.4		164.7 773.9 981.0
V6A (min)	2.5 3.5	.03 .02	.04 .03	.02 .02		.03 .02

TABLE A-7 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 7
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	1.5					no
	2.5					no
	3.5	.40	.33	.31		.35
	5.0	.08	.06			.07
V7A (min)	1.5					no
	2.5	.71	.83			.77
	3.5	.73	.88	.78		.80
V7B (min)	1.5					no
	2.5	.83	.88			.86
	3.5	.53	.68	.51		.57
V7C (min)	1.5					no
	2.5					no
	3.5		.11	.19		.15
V8 (min)	2.5	.42	.40	.40		.41
	5.0	0	0			0

TABLE A-7 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 7
Sidewall Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)	2.5	1.04	1.36	1.03		1.14
V10 (min)		.29	.19	.26	.19	.23

TABLE A-8

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit(0.080 inch thick, beige polycarbonate)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values				Average
		1	2	3	4	
V1A (in/min)	2.5	.86	.72	.90		.83
V1B (in/min)	2.5	1.00	.89	.98		.96
V1C (in/min)	2.5	1.06	1.17	1.13		1.12
V1D (in/min)	2.5 3.5	1.28 2.03	1.85 1.79	1.67 1.74		1.60 1.85
V1E (in/min)	2.5 3.5	1.18 1.79	1.60 2.07	1.21 2.07		1.33 1.98

TABLE A-8 (Continued)
LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)	2.5 3.5 5.0	1.15 2.54 5.63	1.72 2.38 5.14	.98 2.34		1.28 2.42 5.39
V2A (in/min)	1.5 2.5	3.56	2.55	3.03		no 3.05
V2B (in/min)	1.5 2.5	2.66	2.90	3.30		no 2.95
V2C (in/min)	1.5 2.5 3.5	2.95 4.19	4.86 3.21	4.09 3.53		no 3.97 3.64
V2D (in/min)	1.5 2.5 3.5 5.0	2.88 3.05 10.00	2.63 2.86 6.21	1.97 3.50		no 2.49 3.14 8.11

TABLE A-8 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)	1.5 2.5 3.5	 .48 1.37	 1.02 2.07	 .42 1.98		no .64 1.81
V3B (in/min)	1.5 2.5 3.5 5.0	 .86 2.09 5.29	 1.51 2.50 5.45	 .66 2.73		no 1.01 2.44 5.37
V4A1 $[Btu/(ft^2 \cdot min)]$	2.5	461.3	284.3	465.2		403.6
V4A2 $[Btu/(ft^2 \cdot min)]$	2.5 5.0	427.9 589.1	483.7 601.1	594.8		502.1 595.1
V4A3 $[Btu/(ft^2 \cdot min)]$	6.0	578.8	658.2			618.5

TABLE A-8 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8

Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)	2.5	1928.9	1470.0	2152.5		1850.5
V4B2 (Btu/ft^2)	3.5 5.0	2087.2 1476.9	2024.2 1609.7	2942.8		2351.4 1543.3
V4B3 (Btu/ft^2)	6.0	1759.5	1800.2			1779.9
V5A1 (dimensionless)	2.5	705.0	514.3	615.5		611.6
V5A2 (dimensionless)	3.5 5.0	887.0 1176.0	1110.4 1204.1	1030.9		1009.4 1190.0

TABLE A-8 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	5.0 6.0	1005.1 1150.5	1556.1 1064.6			1280.6 1107.6
V5B1 (min^{-1})	2.5 5.0	211.7 799.5	148.9 752.4	160.0		173.5 776.0
V5B2 (min^{-1})	5.0 6.0	1955.7 709.3	1691.0 722.0			1823.4 715.7
V5B3 (min^{-1})						
V6A (min)	2.5 3.5 5.0	.31 .13 .04	.38 .18 .03	.40 .23		.36 .18 .04

TABLE A-8 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	1.5					no
	2.5					no
	3.5					no
	5.0	1.25	1.01	1.13		1.13
	6.0	.50	.50			.50
V7A (min)	1.5	> 10	> 10	> 10		> 10
	2.5	> 10	> 10	> 10		> 10
	3.5	> 10	> 10	> 10		> 10
V7B (min)	1.5	> 10	> 10	> 10		> 10
	2.5	> 10	> 10	> 10		> 10
	3.5	> 10	> 10	> 10		> 10
V7C (min)	1.5					no
	2.5					no
	3.5					no
	5.0	5.65	5.98	6.12		5.92
V8 (min)	1.5					no
	2.5	.56	.39			.48
	3.5	1.83	1.93	1.88		1.88
	5.0	.26	.48	.33		.36
	6.0	.09	.27			.18

TABLE A-8 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)	2.5	4.23	3.94			4.09
V10 (min)		.02	.02	.03	.02	.02

TABLE A-9

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit (0.080 inch thick, beige polycarbonate)
Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	1.4					no
	2.2	1.01	0.86			0.93
H1B (in/min)	1.4					no
	2.2	1.15	1.03			1.09
H1C (in/min)	1.4					no
	2.2	0.86	1.03			0.95
	3.2	2.50	4.11	2.97		3.19
	5.0	3.53	2.86			3.19
H1D (in/min)	1.4					no
	2.2	1.01	0.95			0.98
	3.2	3.23	3.17	3.13		3.18
	5.0	6.06	4.08			5.07
H2A1 [$Btu/(ft^2 \cdot min)$]	2.3	460.3				460.3

TABLE A-9 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [Btu/(ft^2 · min)]	3.2 4.5 5.3	876.5 453.5 325.6	855.0			865.8 453.5 325.6
H2B1 (Btu/ft^2)	2.3	1844.0				1844.0
H2B2 (Btu/ft^2)	3.2 4.5 5.3	2110.2 947.3 1327.9	1912.6			2011.4 947.3 1327.9
H3A1 (dimensionless)	2.3	1281.6				1281.6
H3A2 (dimensionless)	3.2 4.5 5.3	474.3 1386.0 1274.5	522.3			498.3 1386.0 1274.5

TABLE A-9 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8

Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	2.3	592.7				592.7
H3B2 (min^{-1})	3.2 4.5 5.3	464.2 887.6 722.4	456.6			460.4 887.6 722.4
H4A (min)	1.4 2.3 3.2 4.5	 9.50 1.13	 8.08			no no 8.79 1.13
H4B (min)						
H5A (min)	2.3 3.2 4.5	8.55 4.37 5.09	10.60 5.73 7.69	 5.57		9.58 5.22 6.39

TABLE A-9 (Continued)
LABORATORY TEST MEASUREMENTS - MATERIAL NO. 8
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)	1.4 2.3 3.2	 2.65	 1.93			no no 2.29
H6 (min)	1.4 3.2 5.3	 1.29 0.58				no 1.29 0.58
H7 (min)	1.4 2.2 3.2	 > 10				no > 10 no
H8 (min)		0.02	0.02	0.03	0.02	0.02

TABLE A-10

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit (0.040 inch thick, beige polycarbonate)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
VIA (in/min)	1.5 2.5	 0.73	 0.86	 0.83		no 0.81
VIB (in/min)	1.5 2.5	 0.90		 1.24		no 1.07
VIC (in/min)	1.5 2.5	 0.98	 1.08	 1.42		no 1.16
VID (in/min)	1.5 2.5 3.5	 1.40 1.69	 0.99 2.86	 1.69		no 1.36 2.27
VIE (in/min)	1.5 2.5 3.5	 1.26 1.88	 1.24 2.70	 1.68		no 1.39 2.29

TABLE A-10 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)	1.5					no
	2.5	0.83	0.80	1.43		1.02
	3.5	2.34	3.27			2.81
	5.0	6.00	5.54			5.77
V2A (in/min)	1.5					no
	2.5	2.75	3.36	2.81		2.97
V2B (in/min)	1.5					no
	2.5	2.26	2.10	2.48		2.28
V2C (in/min)	1.5					no
	2.5	4.62	2.86	1.76		3.08
	3.5	3.16	5.29			4.23
V2D (in/min)	1.5					no
	2.5	2.43	1.63	0.67		1.58
	3.5	3.13	4.86			4.00
	5.00	10.59	10.00			10.30

TABLE A-10 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9

Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)	1.5					no
	2.5	0.51	0.38	0.92		0.60
	3.5	1.76	5.99			3.53
V3B (in/min)	1.5					no
	2.5	0.91	0.60	1.31		0.94
	3.5	2.01	5.14			3.58
	5.0	7.06	6.00			6.53
V4A1 [Btu/(ft^2 . min)]						
V4A2 [Btu/(ft^2 . min)]	2.5	318.5	309.9	172.5		267.0
	3.5	491.6	334.7			413.2
	5.0	593.8	449.6			521.7
V4A3 [Btu/(ft^2 . min)]	5.0	868.6	681.6			775.1
	6.0	584.3	702.1			643.2

TABLE A-10 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)	2.5 3.5 5.0	1258.1 1682.2 522.4	1625.4 1715.7 413.6	847.4		1243.6 1699.0 468.0
V4B3 (Btu/ft^2)	5.0 6.0	1218.6 1199.8	1196.6 1349.0			1207.6 1274.4
V5A1 (dimensionless)						
V5A2 (dimensionless)	2.5 3.5 5.0	394.7 553.1 740.2	430.0 490.4 692.0	151.7		325.2 521.8 716.1

TABLE A-10 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	5.0	648.7	722.6			685.7
	6.0	736.2	712.0			724.1
V5B1 (min^{-1})						
V5B2 (min^{-1})	2.5	107.7	140.6	33.3		93.9
	3.5	241.1	192.3			216.7
	5.0	1071.6	665.5			868.6
V5B3 (min^{-1})	5.0	1051.6	1000.1			1025.9
	6.0	1252.2	1271.5			1261.9
V6A (min)	2.5	0.07	0.06			0.06
	3.5	0.14	0.15			0.15
	5.0	0.03	0.06			0.05

TABLE A-10 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	1.5 2.5 3.5 5.0 6.0	 0.88 0.25	 0.80			no no no 0.84 0.25
V7A (min)	2.5	> 10	> 10	> 10		> 10
V7B (min)	2.5 3.5 5.0	> 10 7.66 4.50	> 10 9.15 4.08	> 10		> 10 8.40 4.29
V7C (min)	1.5 2.5 3.5 5.0	 3.42	 3.28			no no no 3.35
V8 (min)	3.5	1.48	1.64	1.46		1.53

TABLE A-10 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)	1.5 3.5	> 10				no > 10
V10 (min)						

TABLE A-11

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit (0.040 inch thick, beige polycarbonate)
Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	1.4					no
	2.2	1.56	1.82			1.69
H1B (in/min)	1.4					no
	2.2	0.82				0.82
H1C (in/min)	1.4					no
	2.2	0.83				0.83
	3.2	2.21	3.31	5.71		3.74
	4.5	3.53	3.75			3.64
H1D (in/min)	1.4					no
	2.2	0.99				0.99
	3.2	1.63	2.50	3.08		2.40
	4.5	4.82		3.53		4.13
H2A1 [$Btu/(ft^2 \cdot min)$]	1.4					0
	2.3	260.1				260.1
	3.2	448.0	361.4	482.3		430.6
	4.5	267.6	267.9			267.8

TABLE A-11 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9

Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [$Btu/(ft^2 \cdot min)$]	1.4					0
	2.3					0
	3.2	618.7				618.7
	4.5	152.5				152.5
	5.3	359.1				359.1
H2B1 (Btu/ft^2)	1.4					0
	2.3	1223.8				1223.8
	3.2	1203.5	1169.7	1076.4		1149.9
	4.5	944.9	849.3			897.1
H2B2 (Btu/ft^2)	1.4					0
	2.3					0
	3.2	522.9				522.9
	4.5	231.2				231.2
	5.3	802.3				802.3
H3A1 (dimensionless)	2.3	585.0				585.0
	3.2	786.3	779.8	854.2		806.8
	4.5	775.4	792.1			783.8
H3A2 (dimensionless)	3.2	829.7				829.7
	4.5	852.3				852.3
	5.3	831.1				831.1

TABLE A-11 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm²)	Individual Values				Average
		1	2	3	4	
H3B1 (min^{-1})	2.3 3.2 4.5	183.7 650.6 796.4	 358.3 622.8	 740.3		183.7 583.1 709.6
H3B2 (min^{-1})	3.2 4.5 5.3	1357.2 973.3 847.3				1357.2 973.3 847.3
H4A (min)						
H4B (min)	1.4 2.3 3.2 4.5 5.3	 8.10 3.95 0.81	 7.40	 8.20		no no 7.90 3.95 0.81
H5A (min)	2.3 3.2 4.5	11.26 7.33 7.13	8.69 6.53 6.31	 7.00		9.98 6.95 6.72

TABLE A-11 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 9
Window Reveal, Passenger Service Unit

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)	1.4					no
	2.3					no
	3.2	3.10	2.55	3.60		3.08
	4.5	1.75				1.75
H6 (min)	1.4					no
	2.3					no
	3.2	1.23	1.42	1.38		1.34
	5.3	0.42				0.42
H7 (min)	1.4					no
	2.2					no
	3.2					no
H8 (min)		0.04	0.04	0.06	0.02	0.04

TABLE A-12

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 10

Window Transparency (acrylic)

Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values				Average
		1	2	3	4	
VIA (in/min)	2.5	0.86	1.24	0.94		1.01
VIB (in/min)	2.5	1.28	1.55	1.45		1.43
VIC (in/min)	2.5	1.09	1.13	1.21		1.14
VID (in/min)	2.5 3.5	1.07 1.45	0.93 1.94	1.05 1.60		1.02 1.66
VIE (in/min)	2.5 3.5	1.44 2.53	1.36 1.58	1.34 3.20		1.38 2.44

TABLE A-12 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 10
Window Transparency

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)	2.5 3.5 5.0	1.40 3.24 6.32	1.70 3.64 6.67	1.57 3.87		1.56 3.58 6.49
V2A (in/min)	2.5	4.62	4.68	4.34		4.54
V2B (in/min)	2.5	5.45	6.05	6.92		6.14
V2C (in/min)	2.5 3.5	2.81 4.50	3.10 4.86	2.57 4.50		2.83 4.62
V2D (in/min)	2.5 3.5 5.0	3.60 4.93 10.59	3.46 6.79 11.61	3.46 6.79		3.51 6.17 11.10

TABLE A-12 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 10
Window Transparency

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)	2.5 3.5	0.73 1.50	0.81	0.90 2.12		0.82 1.81
V3B (in/min)	2.5 3.5 5.0	1.20 2.69 7.01	1.23 3.10 6.00	1.25 3.36		1.23 3.05 6.50
V4A1 [Btu/(ft^2 . min)]						
V4A2 [Btu/(ft^2 . min)]	2.5 5.0	896.9 1861.1	863.3			880.1 1861.1
V4A3 [Btu/(ft^2 . min)]	5.0 5.9	1638.5 1962.2	1753.4 1876.9			1696.0 1919.6

TABLE A-12 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 10
Window Transparency

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)	2.5 5.0	2327.4 1907.7	2285.9			2306.7 1907.7
V4B3 (Btu/ft^2)	5.0 5.9	1812.8 2244.6	1525.1 1418.6			1669.0 1831.6
V5A1 (dimensionless)						
V5A2 (dimensionless)	2.5 5.0	527.1 498.5	499.0			513.1 498.5

TABLE A-12 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 10

Window Transparency

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	5.0 5.9	430.8 562.1	338.2 596.0			384.5 579.1
V5B1 (min^{-1})						
V5B2 (min^{-1})	2.5 5.0	297.1 662.0	261.4			279.3 662.0
V5B3 (min^{-1})	5.0	562.0	567.2			564.6
V6A (min)	2.5 3.5 5.0	0.02 0.08 0.04	0.03 0.10 0.04	0.03 0.08		0.03 0.09 0.04

TABLE A-12 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 10
Window Transparency

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	1.5					no
	2.5					no
	3.5	1.76	2.36	1.54		1.89
	5.0	0.83	0.85			0.84
	6.0	0.32	0.37			0.34
V7A (min)	2.5	5.13	4.99	4.97		5.03
V7B (min)	2.5		4.80	5.22		5.01
	3.5	5.00	4.99	5.20		5.06
	5.0		2.73			2.73
V7C (min)	1.5					no
	2.5					no
	3.5	2.37	1.63	2.97	2.37	2.56
	5.0	3.67	2.38			3.03
V8 (min)	2.5	0.75	1.17			0.96
	5.0	0.44	0.42			0.43
	6.0	0.25	0.28			0.27

TABLE A-12 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 10

Window Transparency

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)	1.5					no
V10 (min)		0.08	0.03	0.02	0.03	0.04

TABLE A-13

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 11

Stowage Bin (cream colored)

Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	1.4					no
	2.2	15.00	7.06	4.62		8.89
	3.2	6.32	5.00	4.00		5.11
H1B (in/min)	2.2	18.46	3.16	4.00		8.54
	3.2	6.86	5.85	6.15		6.29
H1C (in/min)	2.2	15.00	3.49	4.23		7.56
	3.2	7.32	5.88	6.12		6.44
H1D (in/min)	3.2	13.04	10.17	10.17		11.13
H2A1 [$Btu/(ft^2 \cdot min)$]	2.3	286.1	276.5	258.5		273.7
	3.2	477.4	428.6			453.0

TABLE A-13 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 11
Stowage Bin

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [$Btu/(ft^2 \cdot min)$]	2.3	272.4	272.1	260.4		268.3
H2B1 (Btu/ft^2)	2.3 3.2	204.9 739.4	188.6 655.9	185.0		192.8 697.7
H2B2 (Btu/ft^2)	2.3	154.9	146.6	143.3		148.3
H3A1 (dimensionless)	2.3 3.2	167.6 8047.3	164.0 6823.4	170.6		167.4 7435.4
H3A2 (dimensionless)	2.3	168.9	166.6	179.1		171.5

TABLE A-13 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 11
Stowage Bin

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	2.3 3.2	556.0 2573.5	614.6 2539.3	630.2		600.3 2556.4
H3B2 (min^{-1})	2.3	549.2	601.9	609.6		586.9
H4A (min)	2.3 3.2	0.03 0.03	0.02 0.01	0.06 0.02		0.04 0.02
H4B (min)						
H5A (min)	3.2	1.79	2.52	2.10		2.14

TABLE A-13 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 11
Stowage Bin

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)						
H6 (min)	2.3 3.2	0.39 0.23	0.40 0.23	0.38		0.39 0.23
H7 (min)	2.2 3.2	1.63 4.74	1.32 4.41	1.44		1.46 4.58
H8 (min)		0.04	0.04	0.04	0.03	0.04

TABLE A-14

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 12
Upper Ceiling Panel
Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	1.4 2.2 3.2	9.23 6.67 10.91	5.45 2.93 8.00	 3.08 12.00		7.34 4.22 10.30
H1B (in/min)	1.4 2.2 3.2	7.74 6.00 7.27	6.49 4.62 7.50	9.60 5.85 9.23		7.94 5.49 8.00
H1C (in/min)	1.4 2.2 3.2 4.5	7.69 6.82 6.52 30.00	5.88 5.00 7.69 16.67	8.57 4.29 10.34		7.38 5.37 8.19 24.93
H1D (in/min)	1.4 2.2 3.2 4.5	 8.00 12.77 37.50	 7.89 15.00 22.22	12.00 6.90 18.18		12.00 7.60 15.32 29.86
H2A1 [$Btu/(ft^2 \cdot min)$]	1.4 2.3	219.4 271.0	178.7 334.4	265.1 295.2		221.1 300.2

TABLE A-14 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 12
Upper Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [Btu/(ft^2 · min)]	2.3 4.5	267.3 682.2	339.0 367.3	295.8 326.8		300.7 458.8
H2B1 (Btu/ft^2)	1.4 2.3	169.4 197.3	203.7 633.6	214.8 239.5		196.0 356.8
H2B2 (Btu/ft^2)	2.3 4.5	175.0 357.1	453.7 174.2	178.6 228.7		269.1 253.3
H3A1 (dimensionless)	1.4 2.3	164.8 172.9	120.5 278.9	167.1 198.6		150.8 216.8
H3A2 (dimensionless)	2.3 4.5	167.6 75.2	281.4 174.2	210.4 109.4		219.8 119.6

TABLE A-14 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 12
Upper Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	1.4	439.3	260.7	510.3		403.4
	2.3	457.9	573.8	645.3		559.0
H3B2 (min^{-1})	2.3	457.4	566.7	629.8		551.3
	4.5	462.4	1016.7	1002.2		827.1
H4A (min)						
H4B (min)	1.4					no
	2.3					no
	3.2					no
	4.5	0.04				0.04
	5.3	0.19	0.18			0.19
H5A (min)	1.4	3.13	4.21	3.11		3.48
	2.3	1.23		1.28		1.25
	3.2	1.59	1.57	1.74		1.63

TABLE A-14 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 12

Upper Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)	1.4					no
	2.3					no
	3.2					no
	4.5	1.63				1.63
H6 (min)	1.4	0.75	0.80			0.78
	2.3	0.36	0.34	0.29		0.33
	3.2	0.19	0.23	0.21		0.21
	5.3	0.08	0.08			0.08
H7 (min)	1.4	2.58	2.13			2.36
	2.2	1.00	1.04	1.13		1.06
	3.2	1.61	2.36	2.58		2.18
H8 (min)		0.13	0.13	0.15	0.04	0.11

TABLE A-15

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 13

Lower Ceiling Panel

Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	2.2	3.87	5.45	17.14		8.82
H1B (in/min)	2.2	5.22	4.14			4.68
H1C (in/min)	2.2	4.73	4.29	23.08		10.7
H1D (in/min)	2.2	6.67	5.94	30.00		14.2
H2A1 [$Btu/(ft^2 \cdot min)$]	2.3	329.3	349.0	314.8		331.0

TABLE A-15 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 13
Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [$Btu/(ft^2 \cdot min)$]						
H2B1 (Btu/ft^2)	2.3	190.2	209.7	220.3		206.7
H2B2 (Btu/ft^2)						
H3A1 (dimensionless)	2.3	203.3	201.0	179.0		194.4
H3A2 (dimensionless)						

TABLE A-15 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 13

Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	2.3	625.0	572.7	517.6		571.8
H3B2 (min^{-1})						
H4A (min)						
H4B (min)						
H5A (min)						

TABLE A-15 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 13
Lower Ceilng Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)						
H6 (min)	2.3	0.13				0.13
H7 (min)	2.2	2.03				2.03
H8 (min)		0.02	0.03	0.03	0.03	0.03

TABLE A-16

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14

Lower Ceiling Panel (brown, perforated)

Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1A (in/min)						
V1B (in/min)						
V1C (in/min)						
V1D (in/min)						
V1E (in/min)						

TABLE A-16 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14
Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)						
V2A (in/min)						
V2B (in/min)						
V2C (in/min)						
V2D (in/min)						

TABLE A-16 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14
Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)						
V3B (in/min)						
V4A1 [$Btu/(ft^2 \cdot min)$]						
V4A2 [$Btu/(ft^2 \cdot min)$]						
V4A3 [$Btu/(ft^2 \cdot min)$]	5.0	642.0				642.0

TABLE A-16 (Continued)
LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14
Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)						
V4B3 (Btu/ft^2)	5.0	395.7				395.7
V5A1 (dimensionless)						
V5A2 (dimensionless)						

TABLE A-16 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14
Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	5.0	180.8				180.8
V5B1 (min^{-1})						
V5B2 (min^{-1})						
V5B3 (min^{-1})	5.0	1037.1				1037.1
V6A (min)						

TABLE A-16 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14
Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)						
V7A (min)						
V7B (min)						
V7C (min)						
V8 (min)						

TABLE A-16 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14
Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)						
V10 (min)						

TABLE A-17
LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14
Lower Ceiling Panel (brown, perforated)
Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values				Average
		1	2	3	4	
H1A (in/min)						
H1B (in/min)						
H1C (in/min)						
H1D (in/min)						
H2A1 [$Btu/(ft^2 \cdot min)$]						

TABLE A-17 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14

Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [$Btu/(ft^2 \cdot min)$]	4.5	246.7				246.7
H2B1 (Btu/ft^2)						
H2B2 (Btu/ft^2)	4.5	319.7				319.7
H3A1 (dimensionless)						
H3A2 (dimensionless)	4.5	333.2				333.2

TABLE A-17 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14

Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})						
H3B2 (min^{-1})	4.5	987.7				987.7
H4A (min)						
H4B (min)						
H5A (min)						

TABLE A-17 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 14

Lower Ceiling Panel

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)						
H6 (min)						
H7 (min)						
H8 (min)						

TABLE A-18

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad (100% Nomex, zirconium treated, 0.5 inch foam pad)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1A (in/min)						
V1B (in/min)						
V1C (in/min)						
V1D (in/min)						
V1E (in/min)						

TABLE A-18 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15

Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)						
V2A (in/min)						
V2B (in/min)						
V2C (in/min)						
V2D (in/min)						

TABLE A-18 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)						
V3B (in/min)						
V4A1 [Btu/(ft^2 . min)]						
V4A2 [Btu/(ft^2 . min)]	5.0	513.7				513.7
V4A3 [Btu/(ft^2 . min)]	2.5 [illegible].0	83.4 505.3	 559.3			83.4 532.3

TABLE A-18 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)	5.0	646.0				646.0
V4B3 (Btu/ft^2)	2.5 5.0	99.9 807.9	 727.6			99.9 767.8
V5A1 (dimensionless)						
V5A2 (dimensionless)	5.0	107.4				107.4

TABLE A-18 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	2.5 5.0	172.8 86.2	 93.2			172.8 89.7
V5B1 (min^{-1})						
V5B2 (min^{-1})	5.0	214.9				214.9
V5B3 (min^{-1})	2.5 5.0	186.2 237.6	 189.2			186.2 213.4
V6A (min)	1.5 2.5 5.0	0.04 0.06 0.01	0.06 0.09	0.08		0.06 0.08 0.01

TABLE A-18 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	5.0 6.0	0.29 0.04	0.33 0.07			0.31 0.05
V7A (min)						
V7B (min)						
V7C (min)	5.0	3.13	3.18			3.16
V8 (min)	5.0 6.0	0.15	0.22			0.18 no

TABLE A-18 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)						
V10 (min)						

TABLE A-19

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad (100% Nomex, zirconium treated, 0.5 inch foam pad)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	1.4	1.24	2.14	2.35		1.91
	2.2	4.29	2.79			3.54
H1B (in/min)	1.4	1.17	1.67	1.98		1.61
	2.2	3.81	4.44			4.13
H1C (in/min)	1.4	1.56	2.22	2.38		2.05
	2.2	5.26	5.08			5.17
	3.2	100.00	24.00	31.58		51.86
	4.5	23.08	150.00			86.54
H1D (in/min)	1.4	2.06	2.67	3.92		2.88
	2.2	8.70	7.89			8.30
	3.2	100.00	33.33	31.58		54.97
	4.5	40.00	40.00			40.00
H2A1 [$Btu/(ft^2 \cdot min)$]	1.4	301.9	163.5	209.0		224.8
	2.3	360.7	325.9			343.3
	3.2	380.5	342.6	420.0		381.0
	4.5	204.6	232.9			218.8

TABLE A-19 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [Btu/(ft^2 · min)]	2.3	328.3	359.1			343.7
	3.2	463.5	186.6			325.1
	4.5	220.7	238.9			229.8
	5.3	415.3				415.3
H2B1 (Btu/ft^2)	1.4	594.6	260.1	252.1		368.9
	2.3	269.1	299.0			284.1
	3.2	710.7	718.2	660.4		696.4
	4.5	838.4	792.6			815.5
H2B2 (Btu/ft^2)	2.3	525.3	580.9			553.1
	3.2	622.2	637.5	559.5		606.4
	4.5	991.4	982.6			987.0
	5.3	1121.2				1121.2
H3A1 (dimensionless)	1.4	164.1	40.9	51.0		85.3
	2.3	85.3	86.0			85.7
	3.2	137.1	153.7	161.6		150.8
	4.5	102.2	98.8			100.5
H3A2 (dimensionless)	2.3	141.8	138.1			140.00
	4.5	136.1	121.1			128.6
	5.3	140.2				140.2

TABLE A-19 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4
H3B1 (min^{-1})	1.4 2.3 4.5	114.8 168.1 244.7	39.0 128.6 172.4	63.8	
H3B2 (min^{-1})	2.3 4.5 5.3	174.5 188.4 298.8	184.0 284.6		
H4A (min)					
H4B (min)	1.4 2.3 3.2 4.5	3.06 0.57 0.23	3.80 3.33 0.31		
H5A (min)	1.4 2.3 3.2 4.5	4.36 1.71 2.91 5.46	2.67 1.94 3.02 4.85	2.06 3.29	

TABLE A-19 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 15
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)	1.4 2.3 3.2 4.5	 2.19 3.35 6.79	 1.36 2.12 5.56			no 1.78 2.73 6.15
H6 (min)	1.4 2.3 3.2 4.5	 0.71 0.10 0.04	 0.73 0.10 0.05	 0.11		no 0.72 0.10 0.05
H7 (min)	1.4 2.2 3.2					no no no
H8 (min)		0.05	0.03	0.03		0.04

TABLE A-20

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad (90% wool, 10% nylon, zirconium treated, 0.5 inch foam pad)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1A (in/min)						
V1B (in/min)						
V1C (in/min)						
V1D (in/min)						
V1E (in/min)						

TABLE A-20 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)						
V2A (in/min)						
V2B (in/min)						
V2C (in/min)						
V2D (in/min)						

TABLE A-20 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)						
V3B (in/min)						
V4A1 [Btu/(ft^2 . min)]						
V4A2 [Btu/(ft^2 . min)]	5.0	1404.7				1404.7
V4A3 [Btu/(ft^2 . min)]						

TABLE A-20 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)	5.0	1080.6				1080.6
V4B3 (Btu/ft^2)						
V5A1 (dimensionless)						
V5A2 (dimensionless)	5.0	110.8				110.8

TABLE A-20 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)						
V5B1 (min^{-1})						
V5B2 (min^{-1})	5.0	353.7				353.7
V5B3 (min^{-1})						
V6A (min)	2.5 5.0	.07 .02				.07 .02

TABLE A-20 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	5.0 6.0	.23 .03	.17 .03			.20 .03
V7A (min)						
V7B (min)	5.0	2.41				2.41
V7C (min)	5.0	2.70	2.60			2.65
V8 (min)	5.0	0.08	0.10			0.09

TABLE A-20 (Continued)
LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)						
V10 (min)						

TABLE A-21

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad (90% wool, 10% nylon, zirconium treated, 0.5 inch foam pad)
Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	2.2	12.00	5.22			8.61
H1B (in/min)	2.2	7.27				7.27
H1C (in/min)	2.2	9.09	11.11			10.10
	3.2	18.18	24.00	23.08		21.75
	4.5	too fast				
H1D (in/min)	2.2	14.29	15.79			15.04
	3.2	28.57	54.55	50.00		44.37
	4.5	too fast				
H2A1 $[Btu/(ft^2 \cdot min)]$	1.4	382.1	339.1			360.6
	2.3	689.3	636.7			663.0
	3.2	639.2	718.4	676.6		678.1
	4.5	518.7				518.7

TABLE A-21 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [$Btu/(ft^2 \cdot min)$]	2.3	482.2				482.2
	3.2	350.5	413.3			381.9
	4.5	615.0				615.0
	5.3	432.7	503.3			468.0
H2B1 (Btu/ft^2)	1.4	302.4	253.7			278.1
	2.3	689.3	636.7			663.0
	3.2	1075.7	910.7	1078.9		1021.8
	4.5	817.5				817.5
H2B2 (Btu/ft^2)	2.3	594.8				594.8
	4.5	819.2				819.2
	5.3	937.3	895.6			916.5
H3A1 (dimensionless)	1.4	34.1	25.1			29.6
	2.3	194.9	128.7			161.8
	3.2	120.0	117.0	122.4		119.8
	4.5	91.3				91.3
H3A2 (dimensionless)	2.3	180.9				180.9
	4.5	93.5				93.5
	5.3	118.2	122.1			120.2

TABLE A-21 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16

Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	1.4	71.6	50.2			60.9
	2.3	258.8	257.1			258.0
	3.2	163.8	196.2	167.5		175.8
	4.5	123.5				123.5
H3B2 (min^{-1})	2.3	306.9				306.9
	4.5	128.4				128.4
	5.3	166.9	227.9			197.4
H4A (min)						
H4B (min)	2.3	3.43	3.88			3.66
	3.2	2.73	3.23			2.98
	4.5	0.14	0.15			0.15
H5A (min)	2.3	2.38				2.38
	3.2	3.47	2.38	3.25		3.03

TABLE A-21 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 16

Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)	2.3 3.2 4.5	1.05 4.38 2.08	1.33 4.57 2.93			1.19 4.47 2.50
H6 (min)	2.3 3.2 4.5	0.28 0.10 0.06	0.30 0.08 0.08			0.29 0.09 0.07
H7 (min)	2.2 3.2					no no
H8 (min)		0.02	0.02	0.02	0.03	0.02

TABLE A-22

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17
Seat Upholstery, Foam Pad (100% wool, zirconium treated, 0.5 inch foam pad)
Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1A (in/min)						
V1B (in/min)						
V1C (in/min)						
V1D (in/min)						
V1E (in/min)						

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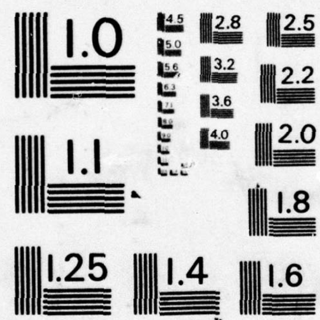

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TABLE A-22 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17

Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)						
V2A (in/min)						
V2B (in/min)						
V2C (in/min)						
V2D (in/min)						

TABLE A-22 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17

Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)						
V3B (in/min)						
V4A1 [$Btu/(ft^2 \cdot min)$]						
V4A2 [$Btu/(ft^2 \cdot min)$]						
V4A3 [$Btu/(ft^2 \cdot min)$]	5.0	786.9	1098.1			942.5

TABLE A-22 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)						
V4B3 (Btu/ft^2)	5.0	974.1	1110.0			1042.1
V5A1 (dimensionless)						
V5A2 (dimensionless)	5.0	72.6				72.6

TABLE A-22 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	5.0	76.5	61.34			68.92
V5B1 (min^{-1})						
V5B2 (min^{-1})	5.0	157.4				157.4
V5B3 (min^{-1})	5.0	131.4	194.4			162.9
V6A (min)	1.5 2.5 5.0	0.13 0.07 0.07	0.13 0.07			0.13 0.07 0.07

TABLE A-22 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17

Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)	5.0 6.0	0.34 0.08	0.25 0.08			0.30 0.08
V7A (min)						
V7B (min)	5.0	3.18				3.18
V7C (min)	5.0	3.09	2.27			2.68
V8 (min)	5.0 6.0	0.12 0.03	0.15 0.04			0.13 0.04

TABLE A-22 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)						
V10 (min)						

TABLE A-23

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17

Seat Upholstery, Foam Pad (100% wool, zirconium treated, 0.5 inch foam pad)

Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H1A (in/min)	1.4	2.67	2.40			2.53
	2.2	9.23	7.06			8.14
H1B (in/min)	1.4	3.43	1.22			2.33
	2.2	8.00	9.23			8.62
H1C (in/min)	1.4	3.70	3.45			3.58
	2.2	15.00	10.00			12.50
	3.2	15.79	16.22	15.38		15.80
	4.5	30.00				30.00
H1D (in/min)	1.4	6.25	5.88			6.07
	2.2	21.43	14.29			17.86
	3.2	33.33	28.57	33.33		31.75
	4.5	33.33				33.33
H2A1 [$Btu/(ft^2 \cdot min)$]	1.4	321.7	260.1			290.9
	2.3	644.0	587.7			615.9
	3.2	606.9	651.4	624.3		627.5

TABLE A-23 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17
Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [$Btu/(ft^2 \cdot min)$]	2.3	508.3				508.3
	4.5	220.7	238.9			229.8
H2B1 (Btu/ft^2)	1.4	752.4	211.1			481.8
	2.3	714.2	494.0			604.1
	3.2	950.1	965.7	906.0		940.6
H2B2 (Btu/ft^2)	2.3	684.4				684.4
	4.5	991.4	982.6			987.0
H3A1 (dimensionless)	1.4	83.3	13.0			48.2
	2.3	58.1	75.1			66.6
	3.2	84.0	37.9	81.8		67.9
H3A2 (dimensionless)	2.3	135.4				135.4
	4.5	136.1		121.1		128.6

TABLE A-23 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17

Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	1.4 2.3 3.2	46.7 129.1 118.0	26.7 103.4 114.4	 114.5		36.7 116.3 115.6
H3B2 (min^{-1})	2.3 4.5	264.8 188.4	 284.6			264.8 236.5
H4A (min)						
H4B (min)	1.4 2.3 3.2 4.5	 5.10 0.41 0.10	 4.28 0.38 0.23			no 4.69 0.39 0.17
H5A (min)	1.4 2.3 3.2 4.5	5.84 5.37 4.64 2.42	2.00 3.60 3.75	 3.43		3.92 4.48 3.94 2.42

TABLE A-23 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 17

Seat Upholstery, Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)	1.4					no
	2.3	0.98	1.92			1.45
	3.2	4.51	5.19			4.85
	4.5	2.73	2.22			2.48
H6 (min)	1.4	0.53				0.53
	2.3	0.33	0.40			0.37
	3.2	0.14				0.14
	4.5	0.03	0.08			0.05
H7 (min)	1.4					> 10
	2.2					no
	3.2					no
H8 (min)		0.02	0.02	0.02	0.03	0.02

TABLE A-24

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18

Seat Cushion Foam Pad (0.5 inch thick, Polyether Urethane)

Vertical Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values				Average
		1	2	3	4	
V1A (in/min)						
V1B (in/min)						
V1C (in/min)						
V1D (in/min)						
V1E (in/min)						

TABLE A-24 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18
Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V1F (in/min)						
V2A (in/min)						
V2B (in/min)						
V2C (in/min)						
V2D (in/min)						

TABLE A-24 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18
Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V3A (in/min)						
V3B (in/min)						
V4A1 [$Btu/(ft^2 \cdot min)$]						
V4A2 [$Btu/(ft^2 \cdot min)$]	5.0	707.5	548.6			628.1
V4A3 [$Btu/(ft^2 \cdot min)$]	5.0 5.9	548.0 1279.5	529.6			538.8 1279.5

TABLE A-24 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18
Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V4B1 (Btu/ft^2)						
V4B2 (Btu/ft^2)	5.0	376.2				376.2
V4B3 (Btu/ft^2)	5.0 5.9	261.5 416.7	175.0			218.3 416.7
V5A1 (dimensionless)						
V5A2 (dimensionless)						

TABLE A-24 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18

Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V5A3 (dimensionless)	5.0 5.9	50.6 44.6	46.6			48.6 44.6
V5B1 (min^{-1})						
V5B2 (min^{-1})						
V5B3 (min^{-1})	5.0	214.9	235.0			225.0
V6A (min)	5.0	0.07	0.08			0.08

TABLE A-24 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18
Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V6B (min)						
V7A (min)						
V7B (min)						
V7C (min)	5.0	1.82	2.34			2.08
V8 (min)						

TABLE A-24 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18
Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
V9 (min)						
V10 (min)						

TABLE A-25

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18
Seat Cushion Foam Pad (0.5 inch thick, Polyether Urethane)
Horizontal Specimen

Data Type	Heat Flux (W/cm^2)	Individual Values				Average
		1	2	3	4	
H1A (in/min)						
H1B (in/min)						
H1C (in/min)						
H1D (in/min)						
H2A1 [$Btu/(ft^2 \cdot min)$]	4.5	556.7				556.7

TABLE A-25 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18

Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H2A2 [$Btu/(ft^2 \cdot min)$]						
H2B1 (Btu/ft^2)	4.5	540.8				540.8
H2B2 (Btu/ft^2)						
H3A1 (dimensionless)	4.5	55.0				55.0
H3A2 (dimensionless)						

TABLE A-25 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18

Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H3B1 (min^{-1})	4.5	388.0				388.0
H3B2 (min^{-1})						
H4A (min)						
H4B (min)						
H5A (min)						

TABLE A-25 (Continued)

LABORATORY TEST MEASUREMENTS - MATERIAL NO. 18
Seat Cushion Foam Pad

Data Type	Heat Flux (W/cm^2)	Individual Values 1	2	3	4	Average
H5B (min)						
H6 (min)						
H7 (min)						
H8 (min)						

TABLE A-26

TOXIC GAS AND SMOKE EMISSIONS DATA FROM THE NBS SMOKE CHAMBER
HEAT FLUX - 2.5 W/cm^2

Material No. (Usage)	Approximate Maximum Concentration (parts per million)					Maximum Specific Optical Density of Smoke	Specific Optical Density of Smoke at 4.0 minutes
	HCN	HCl	HF	CO	SO_2		
1 (carpet and pad)	75	>120		450	250	339	264
2 (carpet and pad)	75	>120		350	300	237	237
7 (sidewall panel)	trace	35	>150	250		46	45
8 (window reveal and passenger service unit)	trace	20	50	0		226	127
10 (window transparency)	trace	80		3000		264	264
13 (lower ceiling panel)	trace	15	60	100		45	45
14 (lower ceiling panel)	2	20	> 90	1000		139	132
15 (seat upholstery and foam pad)	25	25		500		214	204
16 (seat upholstery and foam pad)	50	0		250		245	188
17 (seat upholstery and foam pad)	30	0		100		273	211
19 (sidewall panel, similar to material nos. 3, 4, 5, 6, and 7)	1	> 50	150	500		53	53

TABLE A-27

TOXIC GAS AND SMOKE EMISSIONS DATA FROM THE NBS SMOKE CHAMBER
HEAT FLUX - 5.0 W/cm^2

Material No. (Usage)	Approximate Maximum Concentration (parts per million)					Maximum Specific Optical Density of Smoke	Specific Optical Density of Smoke at 4.0 minutes
	HCN	HCl	HF	CO	SO_2		
1 (carpet and pad)	25	> 120		1000	200	337	336
2 (carpet and pad)	25	> 120			250	339	337
7 (sidewall panel)	4	15	140	90		154	105
8 (window reveal and passenger service unit)	trace	20		2000		354	354
10 (window transparency)	trace	> 120		3000		292	286
13 (lower ceiling panel)	5	10	200	800		100	89
14 (lower ceiling panel)	12	40	400	1000		199	191
15 (seat upholstery and foam pad)	24	> 60		700		191	188
16 (seat upholstery and foam pad)	25	40		1000		132	132
17 (seat upholstery and foam pad)	25	8		1000		171	167
19 (sidewall panel, similar to material nos. 3, 4, 5, 6, and 7)	2	40	100	100		122	97

TABLE A-28

TOXIC GAS AND SMOKE EMISSIONS DATA FROM THE NBS SMOKE CHAMBER HEAT FLUX - 7.5 W/cm^2

Material No. (Usage)	Approximate Maximum Concentration (parts per million)					Maximum Specific Optical Density of Smoke	Specific Optical Density of Smoke at 4.0 minutes
	HCN	HCl	HF	CO	SO_2		
1 (carpet and pad)	12	0		500	60	555	543
2 (carpet and pad)	20	0			100	465	458
7 (sidewall panel)	12	0	15	750		143	127
8 (window reveal and passenger service unit)	1	0		2000		158	157
10 (window transparency)	2	0		3000		159	159
13 (lower ceiling panel)	12	6	15	500		102	97
14 (lower ceiling panel)	25	0	0	500		146	145
15 (seat upholstery and foam pad)	12	0		1000		197	188
16 (seat upholstery and foam pad)	15	0		200		117	117
17 (seat upholstery and foam pad)	20	0		1250		115	113
19 (sidewall panel, similar to material nos. 3, 4, 5, 6, and 7)	5	0	10	500		117	113

APPENDIX B

FLAMMABILITY PROPERTIES OF REPRESENTATIVE WIDE-BODY AIRCRAFT INTERIOR MATERIALS

The data in Tables B-1 through B-23 are values for various material parameters which were derived from the laboratory test measurements in Appendix A. The two values in parentheses below most table entries define the upper and lower limits of the measurements. In most cases, only two or three measurements were made of each parameter and the numbers in parentheses are the lowest and highest of the measurements. The entry in the tables is the mean value of the measurements. Table B-3 presents values derived from averaging all of the sidewall panel data for each parameter. In this case, the values in parentheses are the upper and lower 95% confidence limits. Those values which are confidence limits are marked by an asterisk (*).

No values are presented for Material No. 14 (a ceiling panel) because very little data was measured in the laboratory. No values are presented for Material No. 18 (a seat cushion padding) because this material is not used separately in the cabin. The seat upholstery materials were tested with padding.

The variables for which data is presented are the following.

f_h	horizontal flame spread rate
f_u	vertically upward flame spread rate
f_d	vertically downward flame spread rate
t_p	time to begin smoldering
t_f	time to begin flaming
t_{pc}	time to become charred due to smoldering
t_{fc}	time to become charred due to flaming combustion

r_{sf}	smoke release rate per unit area in the flaming state
r_{ss}	smoke release rate per unit area in the smoldering state
r_h	heat release rate per unit area
$r_f(HCN)$	release rate per unit area of HCN in the flaming state
$r_f(HF)$	release rate per unit area of HF in the flaming state
$r_f(HCl)$	release rate per unit area of HCl in the flaming state
$r_f(CO)$	release rate per unit area of CO in the flaming state
$r_f(SO_2)$	release rate per unit area of SO_2 in the flaming state
t_{pe}	time to cease smoldering when the heat flux is reduced

An entry of "no" in the tables for f_h, f_u, or f_d indicates that the flames did not spread at the heat flux corresponding to the entry. An entry of "no" for t_{fc} indicates that the material did not undergo flaming combustion for the heat flux corresponding to the entry. An entry of "no" for t_p or t_{pc} indicates that the material did not undergo smoldering for the heat flux corresponding to the entry. Blanks in the tables indicate no value could be derived from the laboratory test data for the corresponding entry.

The laboratory test for measuring t_{pe}, the time to cease smoldering when the heat flux is reduced, involved subjecting the specimen to a high flux until smoldering began and then turning off the external heat flux source. The heat flux at which smoldering was induced was not measured and once smoldering began, the heat flux was reduced to zero rather than some intermediate value. Therefore, data was not available for t_{pe} as a function of heat flux. Table B-23 presents values of t_{pe} for the materials for which the results from the above test were reported.

TABLE B-1

FLAMMABILITY PROPERTIES - MATERIAL NO. 1
Carpet and Pad (wool, cut, and loop)
Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.23	1.94	2.82	3.96	4.67
f_h (ft/sec)	.0170 (.0146, .0194)	.0464 (.0439, .0490)	.1389	.4167	
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)	28.8 (27.6, 30.0)	9.0	3.6	2.4	1.2
t_f (sec)					
t_{pc} (sec)	> 600	546.0			
t_{fc} (sec)	> 600	631.8	325.8		

TABLE B-1 (Continued)
FLAMMABILITY PROPERTIES - MATERIAL NO. 1

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.23	1.94	2.82	3.96	4.67
r_{sf} [part/(sec·ft^2)]	< 13.94	18.18 (18.04, 18.31)	35.60 (34.23, 36.53)		
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]	< 2.75	3.33 (3.28, 3.38)	7.08 (6.85, 7.29)		
r_f(HCN) [lb/(sec·ft^2)]		.0000032			
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]		> .0000070			
r_f(CO) [lb/(sec·ft^2)]		.0000203			
r_f(SO_2) [lb/(sec·ft^2)]		.0000257			

TABLE B-2

FLAMMABILITY PROPERTIES - MATERIAL NO. 2

Carpet and Pad (wool, loop pile)

Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.23	1.94	2.82	3.96	4.67
f_h (ft/sec)	.0081 (.0078,.0085)	.0219	.1119 (.0926,.1389)	.1667	
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)	19.2	9.0	5.1 (4.8, 5.4)	4.2 (3.6, 4.8)	1.2 (0.6, 1.8)
t_f (sec)					
t_{pc} (sec)	> 600	636.0	> 600		
t_{fc} (sec)	> 600	530.4 (513.6, 547.8)	280.8 (215.4, 376.8)		

TABLE B-2 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 2

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)] 1.23	1.94	2.82	3.96	4.67
r_{sf} [part/(sec·ft^2)]	< 7.21		26.47		
r_{ss} [part/sec·ft^2)]		12.08			
r_h [Btu/(sec·ft^2)]	< 1.49		4.89		
r_f(HCN) [lb/(sec·ft^2)]		.0000038			
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]		> .0000084			
r_f(CO) [lb/(sec·ft^2)]		.0000188			
r_f(SO_2) [lb/(sec·ft^2)]		.0000368			

TABLE B-3

FLAMMABILITY PROPERTIES - MATERIAL NOS. 3, 4, 5, 6, 7 (AVERAGE)

Sidewall Panel
Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)] 1.32	2.20	3.08	4.41	
f_h (ft/sec)	no	.0093 (.0086, .010)*	.0181 (.0160, .0200)*		
f_u (ft/sec)		.0192 (.0156, .0225)*	.0300 (.0263, .0337)*		
f_d (ft/sec)		.0078 (.0070, .0085)*	.0187 (.0170, .0203)*		
t_p (sec)		19.7 (15.4, 23.8)*			
t_f (sec)		1.9 (0.0, 3.9)*	1.4 (1.4, 1.9)*		
t_{pc} (sec)		66.8 (55.0, 78.5)*			
t_{fc} (sec)	no	51.4 (48.4, 53.9)*	42.4 (29.5, 48.2)*	29.4	

* These numbers are the 95% confidence limits rather than the upper and lower limits of the measurements.

TABLE B-3 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 3, 4, 5, 6, 7 (AVERAGE)

Variable (units)	HEAT FLUX [Btu/($ft^2 \cdot sec$)]			
	1.32	2.20	3.08	4.41
r_{sf} [part/($sec \cdot ft^2$)]		23.15 (19.61, 26.97)	59.23	
r_{ss} [part/$sec \cdot ft^2$)]				
r_h [Btu/($sec \cdot ft^2$)]		2.75 (2.38, 3.07)	4.42	
r_f(HCN) [lb/($sec \cdot ft^2$)]		.0000005		
r_f(HF) [lb/($sec \cdot ft^2$)]		.0000594		
r_f(HCl) [lb/($sec \cdot ft^2$)]		> .0000361		
r_f(CO) [lb/($sec \cdot ft^2$)]		.0002775		
r_f(SO_2) [lb/($sec \cdot ft^2$)]				

TABLE B-4
FLAMMABILITY PROPERTIES - MATERIAL NO. 3
Sidewall Panel
Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)] 1.32	2.20	3.08		
f_h (ft/sec)	no	.0096 (.0081, .0111)	.0149 (.0131, .0179)		
f_u (ft/sec)		.2196 (.0172, .0294)	.0295 (.0278, .0312)		
f_d (ft/sec)		.0066 (.0057, .0073)	.0169 (.0147, .0208)		
t_p (sec)		17.4 (16.8, 18.0)			
t_f (sec)		2.0 (1.8, 2.4)	1.4 (1.2, 1.8)		
t_{pc} (sec)		62.4 (58.8, 70.2)			
t_{fc} (sec)	no	56.4 (54.0, 60.6)	34.2 (30.0, 37.2)		

TABLE B-4 (Continued)
FLAMMABILITY PROPERTIES - MATERIAL NO. 3

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)] 1.32	2.20	3.08		
r_{sf} [part/(sec·ft^2)]		21.78 (20.44, 22.46)	59.23		
r_{ss} [part/sec·ft^2)]		8.05			
r_h [Btu/(sec·ft^2)]		2.38 (2.03, 2.58)	4.77		
r_f(HCN) [lb/(sec·ft^2)]					
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]					
r_f(CO) [lb/(sec·ft^2)]					
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-5

FLAMMABILITY PROPERTIES - MATERIAL NO. 4

Sidewall Panel

Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)] 1.32	2.20	3.08		
f_h (ft/sec)	no	.0104 (.0096, .0111)	.0161 (.0131, .0179)		
f_u (ft/sec)		.0230 (.0179, .0312)	.0253 (.0227, .0294)		
f_d (ft/sec)		.0092 (.0088, .0098)	.0206 (.0200, .0217)		
t_p (sec)		13.2 (12.6, 13.8)			
t_f (sec)		1.2	1.4 (1.2, 1.8)		
t_{pc} (sec)		62.4 (58.8, 67.2)			
t_{fc} (sec)	no	48.6 (44.4, 52.8)	51.0 (34.8, 82.2)		

TABLE B-6

FLAMMABILITY PROPERTIES - MATERIAL NO. 5
Sidewall Panel
Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]			
	1.32	2.20	3.08	
f_h (ft/sec)	no	.0086 (.0085, .0088)	.0183 (.0179, .0192)	
f_u (ft/sec)		.0152 (.0139, .0161)	.0365 (.0294, .0417)	
f_d (ft/sec)		.0079 (.0078, .0081)		
t_p (sec)				
t_f (sec)		2.4	2.2 (1.8, 2.4)	
t_{pc} (sec)				
t_{fc} (sec)	no	52.2 (50.4, 54.0)	57.0 (28.8, 79.8)	

TABLE B-6 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 5

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.32	2.20	3.08		
r_{sf} [part/(sec·ft^2)]		24.24 (21.93, 26.71)			
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]		3.07 (2.79, 3.37)			
r_f(HCN) [lb/(sec·ft^2)]					
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]					
r_f(CO) [lb/(sec·ft^2)]					
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-7

FLAMMABILITY PROPERTIES - MATERIAL NO. 6
Sidewall Panel
Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]			
	1.32	2.20	3.08	4.41
f_h (ft/sec)	no	.0091 (.0073,.0100)	.0235 (.0227,.0250)	
f_u (ft/sec)		.0144 (.0125,.0156)	.0358 (.0333,.0385)	
f_d (ft/sec)		.0086 (.0081,.0089)	.0201 (.0192,.0217)	
t_p (sec)		23.4 (17.4, 34.8)		5.0 (4.8, 5.4)
t_f (sec)		2.4 (1.8, 3.0)	1.8	
t_{pc} (sec)		73.8 (31.2, 102.0)		
t_{fc} (sec)	no	48.0 (45.6, 51.0)	35.4 (32.4, 40.2)	29.4 (16.8, 37.8)

TABLE B-7 (Continued)
FLAMMABILITY PROPERTIES - MATERIAL NO. 6

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.32	2.20	3.08	4.41	
r_{sf} [part/(sec·ft^2)]		26.97 (25.02, 28.06)			
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]		3.01 (2.84, 3.08)	4.07 (4.07, 4.44)		
r_f(HCN) [lb/(sec·ft^2)]					
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]					
r_f(CO) [lb/(sec·ft^2)]					
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-8

FLAMMABILITY PROPERTIES - MATERIAL NO. 7

Sidewall Panel

Vertical Sample

	HEAT FLUX [Btu/(ft^2·sec)]				
Variable (unit)	1.32	2.20	3.08	4.41	
f_h (ft/sec)	no	.0089 (.0081,.0098)	.0176 (.0156,.0200)		
f_u (ft/sec)		.0215 (.0167,.0263)	.0228 (.0217,.0250)		
f_d (ft/sec)		.0066 (.0055,.0078)	.0171 (.0161,.0174)		
t_p (sec)		24.6		0.0	
t_f (sec)		1.8 (1.2, 2.4)	1.4 (1.2, 1.8)		
t_{pc} (sec)		68.4 (60.0, 81.6)			
t_{fc} (sec)	no	51.6 (49.8, 52.8)	34.2 (30.6, 40.8)		

TABLE B-8 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 7

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)] 1.32	2.20	3.08	4.41	
r_{sf} [part/(sec·ft^2)]		20.65 (19.61, 21.63)			
r_{ss} [part/sec·ft^2)]		11.12			
r_h [Btu/(sec·ft^2)]		2.54 (2.41, 2.63)			
r_f(HCN) [lb/(sec·ft^2)]					
r_f(HF) [lb/(sec·ft^2)]		.0000591			
r_f(HCl) [lb/(sec·ft^2)]		.0000252			
r_f(CO) [lb/(sec·ft^2)]		.0001381			
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-9

FLAMMABILITY PROPERTIES - MATERIAL NO. 8
Window Reveal, PSU
Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)] 1.32	2.20	3.08	4.41	5.29
f_h (ft/sec)		.0018 (.0014, .0024)	.0034 (.0032, .0035)	.0075 (.0071, .0078)	
f_u (ft/sec)	no	.0035 (.0027, .004)	.0044 (.0040, .0049)	.0113 (.0086, .0139)	
f_d (ft/sec)	no	.0014 (.0009, .0021)	.0034 (.0029, .0038)	.0075 (.0073, .0076)	
t_p (sec)	no		112.8 (109.8, 115.8)	21.0 (15.6, 28.8)	10.8 (2.4, 16.2)
t_f (sec)		21.6 (18.6, 24.0)	10.8 (7.8, 13.8)	2.1 1.8, 2.4)	
t_{pc} (sec)		245.4 (236.4, 253.8)			
t_{fc} (sec)		> 600	> 600	355.2 (339.0, 367.2)	

TABLE B-9 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 8

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.32	2.20	3.08	4.41	5.29
r_{sf} [part/(sec·ft^2)]				43.21 (42.80, 43.85)	
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]					
r_f(HCN) [lb/(sec·ft^2)]					
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]				.0000020	
r_f(CO) [lb/(sec·ft^2)]				.0001605	
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-10

FLAMMABILITY PROPERTIES - MATERIAL NO. 8

Window Reveal, PSU

Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)] 1.23	1.94	2.82	3.96	4.67
f_h (ft/sec)	no	.0014 (.0013,.0014)	.0044 (.0043,.0045)	.0070 (.0057,.0084)	
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)	no		77.4		34.8
t_f (sec)					
t_{pc} (sec)	no		no		
t_{fc} (sec)		574.8 (513.0, 636.0)	313.2 (262.2, 343.8)	383.4 (305.4, 461.4)	

TABLE B-10 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 8

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.23	1.94	2.82	3.96	4.67
r_{sf} [part/(sec·ft^2)]		48.72			
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]		3.21			
r_f(HCN) [lb/(sec·ft^2)]					
r_f(HF) [lb/(sec·ft^2)]		.0000017			
r_f(HCl) [lb/(sec·ft^2)]		.0000012			
r_f(CO) [lb/(sec·ft^2)]		0.0			
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-11

FLAMMABILITY PROPERTIES - MATERIAL NO. 9
Window Reveal, PSU
Vertical Sample

	HEAT FLUX [Btu/(ft^2 · sec)]				
Variable (unit)	1.32	2.20	3.08	4.41	
f_h (ft/sec)	no	.0014 (.0011, .0019)	.0039 (.0032, .0045)	.0080 (.0077, .0083)	
f_u (ft/sec)	no	.0022 (.0009, .0034)	.0056 (.0043, .0067)	.0143 (.0139, .0147)	
f_d (ft/sec)	no	.0013 (.0008, .0018)	.0050 (.0028, .0071)	.0091 (.0083, .0098)	
t_p (sec)			91.8 (87.6, 98.4)		
t_f (sec)		3.9 (3.6, 4.2)	8.7 (8.4, 9.0)	2.4 (1.8, 3.6)	
t_{pc} (sec)	no		> 600		
t_{fc} (sec)		> 600	504.0 (459.6, 549.0)	257.4 (244.8, 270.0)	

TABLE B-11 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 9

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)] 1.32	2.20	3.08	4.41	
r_{sf} [part/(sec·ft^2)]				60.80 (59.91, 61.77)	
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]		> 2.07		1.82 (1.69, 1.93)	
r_f(HCN) [lb/(sec·ft^2)]					
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]					
r_f(CO) [lb/(sec·ft^2)]					
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-12

FLAMMABILITY PROPERTIES - MATERIAL NO. 9
Window Reveal, PSU
Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]			
	1.23	1.94	2.82	3.96
f_h (ft/sec)	no	.0014	.0033 (.0023, .0043)	.0051 (.0049, .0052)
f_u (ft/sec)				
f_d (ft/sec)				
t_p (sec)	no	no	no	
t_f (sec)				
t_{pc} (sec)	no	no	no	
t_{fc} (sec)		598.8 (521.4, 675.6)	417.0 (391.8, 439.8)	403.2 (378.6, 427.8)

TABLE B-12 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 9

Variable (units)	HEAT FLUX [Btu/(ft^2 · sec)]			
	1.23	1.94	2.82	3.96
r_{sf} [part/(sec · ft^2)]		21.35	42.28 (39.07, 44.45)	42.48 (36.53, 45.72)
r_{ss} [part/sec · ft^2)]				
r_h [Btu/(sec · ft^2)]		2.04	2.76 (2.56, 2.98)	2.22 (2.04, 2.24)
r_f(HCN) [lb/(sec · ft^2)]				
r_f(HF) [lb/(sec · ft^2)]				
r_f(HCl) [lb/(sec · ft^2)]				
r_f(CO) [lb/(sec · ft^2)]				
r_f(SO_2) [lb/(sec · ft^2)]				

TABLE B-13

FLAMMABILITY PROPERTIES - MATERIAL NO. 10
Window Transparency
Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.32	2.20	3.08	4.41	5.29
f_h (ft/sec)		.0022 (.0019, .0024)	.0050 (.0045, .0054)	.0090 (.0088, .0093)	
f_u (ft/sec)		.0049 (.0048, .0050)	.0086 (.0068, .0094)	.0154 (.0147, .0161)	
f_d (ft/sec)		.0017	.0042 (.0037, .0047)	.0090 (.0083, .0097)	
t_p (sec)		57.6 (46.8, 70.2)		25.8 (25.2, 26.4)	15.6 (12.0, 16.8)
t_f (sec)		1.6 (1.2, 1.8)	5.4 (4.8, 6.0)	2.4	
t_{pc} (sec)	no				
t_{fc} (sec)		300.6 (288.0, 313.2)	303.6 (299.4, 312.0)	163.8	

TABLE B-13 (Continued)
FLAMMABILITY PROPERTIES - MATERIAL NO. 10

Variable (units)	HEAT FLUX $[Btu/(ft^2 \cdot sec)]$				
	1.32	2.20	3.08	4.41	5.29
r_{sf} $[part/(sec \cdot ft^2)]$		37.29 (34.82, 39.99)		66.51	
r_{ss} $[part/sec \cdot ft^2)]$					
r_h $[Btu/(sec \cdot ft^2)]$		7.67 (7.30, 8.08)		11.66	
$r_f(HCN)$ $[lb/(sec \cdot ft^2)]$					
$r_f(HF)$ $[lb/(sec \cdot ft^2)]$					
$r_f(HCl)$ $[lb/(sec \cdot ft^2)]$		.0000098			
$r_f(CO)$ $[lb/(sec \cdot ft^2)]$		.0002844			
$r_f(SO_2)$ $[lb/(sec \cdot ft^2)]$					

TABLE B-14

FLAMMABILITY PROPERTIES - MATERIAL NO. 11

Stowage Bin

Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.23	1.94	2.82		
f_h (ft/sec)			.0155 (.0141, .0181)		
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)		23.4 (22.8, 24.0)	13.8		
t_f (sec)		2.4 (1.2, 3.6)	1.2 (0.6, 1.8)		
t_{pc} (sec)		87.6 (79.2, 97.8)	274.8 (264.6, 284.4)		
t_{fc} (sec)			128.4 (107.4, 151.2)		

TABLE B-14 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 11

Variable (units)	HEAT FLUX $[Btu/(ft^2 \cdot sec)]$				
	1.23	1.94	2.82		
r_{sf} $[part/(sec \cdot ft^2)]$					
r_{ss} $[part/sec \cdot ft^2)]$					
r_h $[Btu/(sec \cdot ft^2)]$			5.43 (4.34, 6.88)		
$r_f(HCN)$ $[lb/(sec \cdot ft^2)]$					
$r_f(HF)$ $[lb/(sec \cdot ft^2)]$					
$r_f(HCl)$ $[lb/(sec \cdot ft^2)]$					
$r_f(CO)$ $[lb/(sec \cdot ft^2)]$					
$r_f(SO_2)$ $[lb/(sec \cdot ft^2)]$					

TABLE B-15

FLAMMABILITY PROPERTIES - MATERIAL NO. 12
Upper Ceiling Panel
Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.23	1.94	2.82	3.96	4.67
f_h (ft/sec)		.0106 (.0096, .0111)	.0213 (.0177, .0252)	.0415 (.0309, .0521)	
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)	46.8 (45.0, 48.0)	19.8 (17.4, 21.6)	12.6 (11.4, 13.8)		4.8
t_f (sec)					
t_{pc} (sec)	141.6 (127.8, 154.8)	63.6 (60.0, 67.8)	130.8 (96.6, 154.8)		
t_{fc} (sec)	208.8 (186.6, 252.6)	75.0 (73.8, 76.8)	97.8 (94.2, 104.4)		

TABLE B-15 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 12

Variable (units)	HEAT FLUX $[Btu/(ft^2 \cdot sec)]$				
	1.23	1.94	2.82	3.96	4.67
r_{sf} $[part/(sec \cdot ft^2)]$	84.50 (52.88, 107.18)	63.17 (51.2, 81.26)			
r_{ss} $[part/sec \cdot ft^2)]$		75.52			
$\dot{r}_h$ $[Btu/(sec \cdot ft^2)]$	5.54 (4.09, 8.03)	4.76 (2.67, 8.45)			
$r_f(HCN)$ $[lb/(sec \cdot ft^2)]$					
$r_f(HF)$ $[lb/(sec \cdot ft^2)]$		.0000162			
$r_f(HCl)$ $[lb/(sec \cdot ft^2)]$		.0000074			
$r_f(CO)$ $[lb/(sec \cdot ft^2)]$		.0000380			
$r_f(SO_2)$ $[lb/(sec \cdot ft^2)]$					

TABLE B-16

FLAMMABILITY PROPERTIES - MATERIAL NO. 13
Lower Ceiling Panel
Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)] 1.23	1.94	2.82		
f_h (ft/sec)		.0166 (.0082, .0417)			
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)		7.8			
t_f (sec)					
t_{pc} (sec)		121.8			
t_{fc} (sec)					

TABLE B-17

FLAMMABILITY PROPERTIES - MATERIAL NO. 15
Seat Upholstery and Foam Pad
Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.23	1.94	2.82	3.96	
f_h (ft/sec)	.0040 (.0029, .0054	.0115 (.0109, .0121)	.0764 (.0439, .1389)	.0556	
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)	no	43.2 (42.6, 43.8)	6.2 (6.0, 6.6)	2.7 (2.4, 3.0)	
t_f (sec)					
t_{pc} (sec)	no				
t_{fc} (sec)	181.8 (123.6, 261.6)	109.8 (102.6, 116.4)	184.2 (174.6, 197.4)	309.6 (291.0, 327.6)	

TABLE B-17 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 15

Variable (units)	HEAT FLUX $[Btu/(ft^2 \cdot sec)]$			
	1.23	1.94	2.82	3.96
r_{sf} $[part/(sec \cdot ft^2)]$	10.25 (5.58, 13.71)	17.06 (16.15, 18.17)	17.89 (17.16, 18.54)	7.09 (6.82, 7.42)
r_{ss} $[part/sec \cdot ft^2)]$				
r_h $[Btu/(sec \cdot ft^2)]$	2.03 (1.62, 2.27)	2.59 (2.57, 2.62)	3.78 (3.34, 4.07)	2.63 (2.56, 2.72)
$r_f(HCN)$ $[lb/(sec \cdot ft^2)]$		.0000062		
$r_f(HF)$ $[lb/(sec \cdot ft^2)]$				
$r_f(HCl)$ $[lb/(sec \cdot ft^2)]$		.0000084		
$r_f(CO)$ $[lb/(sec \cdot ft^2)]$		.0001298		
$r_f(SO_2)$ $[lb/(sec \cdot ft^2)]$				

TABLE B-18

FLAMMABILITY PROPERTIES - MATERIAL NO. 15
Seat Upholstery and Foam Pad
Vertical Sample

Variable (unit)	HEAT FLUX $[Btu/(ft^2 \cdot sec)]$				
	1.32	2.20	3.08	4.41	
f_h (ft/sec)					
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)				10.8 (9.0, 13.2)	
t_f (sec)	3.6 (2.4, 4.8)	4.8 (3.6, 5.4)		0.6	
t_{pc} (sec)					
t_{fc} (sec)				189.6 (187.8, 190.8)	

TABLE B-18 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 15

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.32	2.20	3.08	4.41	
r_{sf} [part/(sec·ft^2)]				12.38	
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]				3.41	
r_f(HCN) [lb/(sec·ft^2)]				.0000034	
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]				.0000117	
r_f(CO) [lb/(sec·ft^2)]				.0001052	
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-19

FLAMMABILITY PROPERTIES - MATERIAL NO. 16
Seat Upholstery and Foam Pad
Horizontal Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]			
	1.23	1.94	2.82	3.96
f_h (ft/sec)		.0209 (.0198, .0219)	.0616 (.0397, .0758)	
f_u (ft/sec)				
f_d (ft/sec)				
t_p (sec)		17.4 (16.8, 18.0)	5.4 (4.8, 6.0)	4.2 (3.6, 4.8)
t_f (sec)				
t_{pc} (sec)				
t_{fc} (sec)		142.8	181.8 (142.8, 208.2)	

TABLE B-19 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 16

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)] 1.23	1.94	2.82	3.96
r_{sf} [part/(sec·ft^2)]		24.76 (19.70, 29.83)	14.40 (12.59, 17.90)	
r_{ss} [part/sec·ft^2)]				
r_h [Btu/(sec·ft^2)]		4.64 (4.46, 4.83)	5.62 (5.17, 6.38)	
r_f(HCN) [lb/(sec·ft^2)]		.0000096		
r_f(HF) [lb/(sec·ft^2)]				
r_f(HCl) [lb/(sec·ft^2)]		0.0		
r_f(CO) [lb/(sec·ft^2)]		.0000499		
r_f(SO_2) [lb/(sec·ft^2)]				

TABLE B-20
FLAMMABILITY PROPERTIES - MATERIAL NO. 16
Seat Upholstery and Foam Pad
Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)] 1.32	2.20	3.08	4.41	
f_h (ft/sec)					
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)				5.4 (4.8, 6.0)	
t_f (sec)		3.6 (3.0, 4.2)		1.2	
t_{pc} (sec)					
t_{fc} (sec)				144.6	

TABLE B-20 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 16

Variable (units)	HEAT FLUX [Btu/(ft^2· sec)]				
	1.32	2.20	3.08	4.41	
r_{sf} [part/(sec· ft^2)]				16.74	
r_{ss} [part/sec· ft^2)]					
r_h [Btu/(sec· ft^2)]				7.47	
r_f(HCN) [lb/(sec· ft^2)]				.0000047	
r_f(HF) [lb/(sec· ft^2)]					
r_f(HCl) [lb/(sec· ft^2)]				.0000102	
r_f(CO) [lb/(sec· ft^2)]				.0001971	
r_f(SO_2) [lb/(sec· ft^2)]					

TABLE B-21

FLAMMABILITY PROPERTIES - MATERIAL NO. 17
Seat Upholstery and Foam Pad
Horizontal Sample

Variable (unit)	HEAT FLUX $[Btu/(ft^2 \cdot sec)]$ 1.23	1.94	2.82	3.96	
f_h (ft/sec)	.0084 (.0082, .0087)	.0248 (.0198, .0298)	.0441 (.0397, .0463)	.0463	
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)	31.8	22.2 (19.8, 24.0)	8.4	3.0 (1.8, 4.8)	
t_f (sec)					
t_{pc} (sec)	> 600				
t_{fc} (sec)	235.2 (120.0, 350.4)	268.8 (216.0, 322.2)	236.4 (205.8, 278.4)		

TABLE B-21 (Continued)
FLAMMABILITY PROPERTIES - MATERIAL NO. 17

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.23	1.94	2.82	3.96	
r_{sf} [part/(sec·ft^2)]	4.47 (2.37, 5.19)	5.41 (3.94, 7.60)	6.28 (3.68, 8.69)		
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]	2.05 (1.76, 2.15)	2.25 (2.22, 2.29)	3.98 (3.41, 4.40)		
$r_f(HCN)$ [lb/(sec·ft^2)]		.0000030			
$r_f(HF)$ [lb/(sec·ft^2)]					
$r_f(HCl)$ [lb/(sec·ft^2)]		0.0			
$r_f(CO)$ [lb/(sec·ft^2)]		.0000106			
$r_f(SO_2)$ [lb/(sec·ft^2)]					

TABLE B-22

FLAMMABILITY PROPERTIES - MATERIAL NO. 17
Seat Upholstery and Foam Pad
Vertical Sample

Variable (unit)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.32	2.20	3.08	4.41	5.29
f_h (ft/sec)					
f_u (ft/sec)					
f_d (ft/sec)					
t_p (sec)				7.8 (7.2, 9.0)	2.1 (1.8, 2.4)
t_f (sec)	7.8	4.2			
t_{pc} (sec)					
t_{fc} (sec)				190.8	

TABLE B-22 (Continued)

FLAMMABILITY PROPERTIES - MATERIAL NO. 17

Variable (units)	HEAT FLUX [Btu/(ft^2·sec)]				
	1.32	2.20	3.08	4.41	5.29
r_{sf} [part/(sec·ft^2)]				8.31	
r_{ss} [part/sec·ft^2)]					
r_h [Btu/(sec·ft^2)]					
r_f(HCN) [lb/(sec·ft^2)]				.0000036	
r_f(HF) [lb/(sec·ft^2)]					
r_f(HCl) [lb/(sec·ft^2)]				.0000015	
r_f(CO) [lb/(sec·ft^2)]				.0001493	
r_f(SO_2) [lb/(sec·ft^2)]					

TABLE B-23

VALUES OF t_{pe} FOR SEVERAL MATERIALS

Material Number	Specimen Orientation	Material Usage	Mean Value of t_{pe} in Seconds (lower limit, upper limit)
3	Vertical	Sidewall Panel	12.6 (10.8, 15.6)
7	Vertical	Sidewall Panel	14.4 (11.4, 17.4)
8	Vertical	Window Reveal, Passenger Service Unit	1.4 (1.2, 1.8)
8	Horizontal	Window Reveal, Passenger Service Unit	1.4 (1.2, 1.8)
9	Horizontal	Window Reveal, Passenger Service Unit	2.4 (1.2, 3.6)
10	Vertical	Window Transparency	2.4 (1.2, 4.8)
11	Horizontal	Stowage Bin	2.3 (1.8, 2.4)
12	Horizontal	Upper Ceiling Panel	6.6 (2.4, 9.0)
13	Horizontal	Lower Ceiling Panel	1.7 (1.2, 1.8)
15	Horizontal	Seat Upholstery and Foam Pad	2.4 (1.8, 3.0)
16	Horizontal	Seat Upholstery and Foam Pad	1.4 (1.2, 1.8)
17	Horizontal	Seat Upholstery and Foam Pad	1.4 (1.2, 1.8)

APPENDIX C

OBTAINING SMOKE EMISSION RATE IN "PARTICLES" PER UNIT AREA PER UNIT TIME FROM SPECIFIC OPTICAL DENSITY DATA

The optical density, D, of a smoke layer is defined as

$$D = \log_{10} \frac{100}{T} \tag{C-1}$$

where T is the percent of light transmission over the layer thickness. The smoke "concentration" is related to the optical density by the equation

$$D = kSL \tag{C-2}$$

where k is a proportionality constant, S is the smoke concentration, and L is the length of the light path over which the transmission is T. A concentration of one "particle" per cubic foot is arbitrarily defined as that amount of smoke which, if contained in a one cubic foot volume, would reduce the light transmission by 10% over a path length of one foot [see Reference 2 in Section 2]. The value of k based on Equations C-1 and C-2 is then

$$k = \log_{10} \frac{100}{90} = 0.04576 \tag{C-3}$$

when S is in units of particles per cubic foot. The relationship between the percent light transmission and the concentration in particles per cubic foot is

$$\log_{10} \frac{100}{T} = \left(\log_{10} \frac{100}{90}\right) SL \quad . \tag{C-4}$$

This equation can be rewritten as

$$T = 100\,(.9)^{SL} \quad . \tag{C-5}$$

Over a path length of one foot, the percent transmission for a concentration of one particle per cubic foot would be 90%; for two particles per cubic foot,

the transmission would be 100 $(.9)^2$ or 81%; for three particles per cubic foot, the transmission would be 100 $(.9)^3$ or 72.9%; etc.

The maximum specific optical density, D_S^{max}, is computed from the OSU Combustion Analyzer by the equation

$$D_S^{max} = \frac{1}{AL} \int_o^{t_b} \dot{V} \log_{10} \left(\frac{100}{T(t)} \right) dt \qquad (C-6)$$

where A is the area of the specimen burned, $\dot{V}$ is the rate at which gas moves through the chamber in units of volume per unit time, and t_b is the time of burning. Combining Equations C-1 and C-2 and substituting into Equation C-6 yields

$$D_S^{max} = \frac{1}{AL} \int_o^{t_b} \dot{V}(t)\, kS(t)L\, dt \quad , \qquad (C-7)$$

or

$$D_S^{max} = \frac{k}{A} \int_o^{t_b} \dot{V}(t)\, S(t)\, dt \quad . \qquad (C-8)$$

The product $\dot{V}(t)\, S(t)$ is equal to the rate at which smoke is passing out of the chamber in particles per second. Thus, the integral in Equation C-8 yields the total number of particles produced, P_T. The equation for the maximum specific optical density becomes

$$D_S^{max} = \frac{k}{A} P_T \quad . \qquad (C-9)$$

The emission rate of smoke per unit area, r_s, is the total number of particles emitted divided by the specimen area and the burn time; that is,

$$r_s = \frac{P_T}{At_b} \quad . \qquad (C-10)$$

Combining Equations C-9 and C-10 yields

$$r_s = \frac{D_S^{max}}{kt_b} \quad . \tag{C-11}$$

Thus, r_s in units of particles per unit area per unit time can be found by dividing the maximum specific optical density by the burn time and by 0.04576, the value of k.

APPENDIX D

OBTAINING TOXIC GAS EMISSION RATES FROM NBS SMOKE CHAMBER DATA

The concentration of toxic gases in the NBS Smoke Chamber is measured in parts per million by volume. The DACFIR Model employs toxic gas release rates in units of mass (pounds) per unit area (ft^2) per unit time (sec). This appendix presents the derivation of the method of estimating the toxic gas release rate from the measured gas concentration in the NBS Chamber and the burning time as measured by the OSU Combustion Analyzer.

The ideal gas law gives the equation of state of a gas as

$$PV = n\,RT \tag{D-1}$$

where P is the pressure, V is the volume occupied by the gas, n is the number of moles, R is the universal gas constant, and T is the absolute temperature. The number of moles of the gas is equal to its mass in grams, m, divided by the gram molecular weight of the gas, W. Equation D-1 then can be rewritten as

$$m = \frac{PV\,W}{RT} \quad . \tag{D-2}$$

The number of molecules of a gas, N, is given by the equation

$$N = N_o\left(\frac{m}{W}\right) \tag{D-3}$$

where N_o is Aragadro's number (6.023×10^{23} molecules per gram-mole). Thus in the NBS Smoke Chamber the number of molecules of a particular toxic gas, N_g, is

$$N_g = N_o\left(\frac{m_g}{W_g}\right) \tag{D-4}$$

where m_g is the mass of the toxic gas in the chamber in grams and W_g is molecular weight of the gas. The concentration of the toxic gas in parts per million, C(ppm), is defined as the number of molecules of the toxic gas of interest per million gas molecules in the chamber. That is,

$$C(\text{ppm}) = \frac{N_g}{\left(N_t/10^6\right)} = \frac{N_g}{N_t}\, 10^6 \qquad \text{(D-5)}$$

where N_t is the total number of gas molecules in the chamber. The total number of gas molecules in the chamber is approximately equal to the number of air molecules, N_a, in the chamber before the test began. With this approximation

$$C(\text{ppm}) = \frac{N_g}{N_a}\, 10^6 \quad . \qquad \text{(D-6)}$$

The number of air molecules in the chamber prior to the test is, according to Equations D-2 and D-3,

$$N_a = N_o \frac{P_r V_c}{RT_r} \qquad \text{(D-7)}$$

where V_c is the volume of the chamber and T_r and P_r are the room temperature and pressure, respectively. Substituting Equations D-4 and D-7 into Equation D-6 yields

$$C(\text{ppm}) = \frac{m_g RT_r}{W_g P_r V_c}\, 10^6 \quad . \qquad \text{(D-8)}$$

According to this equation the mass of the particular toxic gas in the chamber at any time is then

$$m_g = \frac{W_g P_r V_c C(\text{ppm})}{RT_r}\, 10^{-6} \quad . \qquad \text{(D-9)}$$

The following values can be substituted into Equation D-9.

$$\begin{aligned}
V_c &= 18\ \text{ft}^3 = 5.097 \times 10^5\ \text{cm}^3 \\
P_r &= 1\ \text{atm} = 1.013 \times 10^6\ \text{dynes/cm}^2 \\
R &= 8.32 \times 10^7\ \text{ergs/(mole} \cdot {}^{o}\text{K)} \\
T_r &= 72.4\ {}^{o}\text{F} = 295.6\ {}^{o}\text{K}
\end{aligned}$$

The result is

$$m_g = 2.0994 \times 10^{-5}\ C(\text{ppm})\ W_g \quad . \qquad \text{(D-10)}$$

The emission of the toxic gas per unit area, R', is found by dividing m_g by the area of the specimen, 42.26 cm^2.

$$R'(g/cm^2) = 4.9678 \times 10^{-7} \; C(ppm) \; W_g \quad \text{(D-11)}$$

When the units of R' are converted from grams per square centimeter to pounds per square foot, Equation D-11 becomes

$$R'(lbs/ft^2) = 1.0180 \times 10^{-6} \; C(ppm) \; W_g \; . \quad \text{(D-12)}$$

This equation can be used to compute the amount of a toxic gas emitted per unit area of the specimen in the NBS Smoke Chamber when the peak concentration of the gas in the chamber is known in parts per million. This quantity is then divided by the burn time of the specimen to obtain the average release rate per unit area for the toxic gas.

REFERENCES

[1] Constantine P. Sarkos, "Measurements of Toxic Gases and Smoke from Aircraft Cabin Interior Materials Using the NBS Smoke Chamber and Colorimetric Tubes", National Aviation Facilities Experimental Center, FAA-RD-76-7, March 1976.

[2] E.E. Smith, "Measuring Rates of Heat, Smoke, and Toxic Gas Release," Fire Technology 8, No. 3(1972).